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Corsair's Hydro Brackets Convert CPU Coolers Into GPU Coolers

Corsair has a new trick up its sleeve for owners of Hydro Series CPU coolers. The company has released two new brackets that convert the CPU coolers into GPU coolers. The Hydro Series HG10 980 and HG10 970 work with NVIDIA GPUs on stock reference design cards. The HG10 980 works on GeForce GTX 980 Ti, Titan X, and GTX 980 cards, while the HG10 970 works on GeForce GTX 970 cards. Both brackets are aluminum and incorporate a 70mm low-noise fan. Corsair says the HG10 N980 cools both the memory and VRMs, while the HG10 N970 cools just the VRMs. Both brackets replace the air-cooling system on cards with a frame that supports the full range of Corsair Hydro Series liquid coolers. Corsair says using the brackets to replace air cooling with Hydro Series liquid cooling gives users the headroom to increase clock speeds by up to 25%.

ASUS RT-AC5300 Tri-Band Wi-Fi Router For Gamers & Enthusiasts

ASUS is bringing out a new router that is sure to get the attention of gamers and enthusiasts looking to coax as much speed as possible out of their wireless networks. The RT-AC5300 is a tri-band router (using one 2.4GHz and two 5GHz frequency bands) that incorporates NitroQAM technology from Broadcom to boost the speed over each channel by up to 25% (from 1,734Mbps to 2,167Mbps for 5GHz, and from 800Mbps to 1,000Mbps for 2.4GHz). ASUS says the result is a router with five times as much throughput as a wired Gigabit Ethernet connection. A built-in gaming accelerator powered by WTFast's GPN (Gamers Private Network) increases the speed even more for gamers. ASUS says GPN reduces ping times on multiplayer games by as much as 60% and that it supports "virtually all" online competitive multiplayer games.

WATCHING THE CHIPS FALL

Here is the pricing information for various AMD and Intel CPUs.

* As of November 2015
** Manufacturer's estimated price per 1,000

CPU	Released	Original Price	Last Month's Price	Online Retail Price*
AMD FX-9590 Eight-Core	6/11/2013	N/A	$239.99	$239.99
AMD FX-9370 Eight-Core	6/11/2013	$375	$209.99	$209.99
AMD FX-8350 Eight-Core	10/23/2012	$195	$169.99	$169.99
AMD FX-8320 Eight-Core	10/23/2012	$169	$144.99	$144.99
AMD FX-6350 Six-Core	4/30/2013	$132	$125.95	$126.99
AMD A10-7850K Quad-Core	1/14/2014	$173	$129.99	$129.99
AMD A10-7800 Quad-Core	7/2/2014	$153	$129.99	$126.99
AMD A10-7700K Quad-Core	1/14/2014	$152	$119.99	$114.99
AMD A10-6800K Quad-Core	6/4/2013	$142**	$129.49	$109.99
AMD A10-5800K Quad-Core	10/2/2012	$122**	$89.99	$89.99
Intel Core i7-5960X Eight-Core	8/29/2014	$999**	$1,049.99	$1,049.99
Intel Core i7-4960X Six-Core	9/3/2013	$990**	$1,024.99	$1,024.99
Intel Core i7-5930K Six-Core	8/29/2014	$583**	$584.99	$459.99
Intel Core i7-4930K Six-Core	9/3/2013	$583**	$599.99	$599.99
Intel Core i7-5820K Six-Core	8/29/2014	$389**	$389.99	$389.99
Intel Core i7-6700K Quad-Core (Skylake)	8/5/2015	$359**	$369.99	$399.99
Intel Core i7-4790K Quad-Core	6/25/2014	$339**	$339.99	$299.99
Intel Core i7-4820K Quad-Core	9/3/2013	$323**	$329.99	$329.99
Intel Core i7-4790 Quad-Core	5/11/2014	$303**	$309.99	$309.99
Intel Core i5-6600K Quad-Core (Skylake)	8/5/2015	$249**	$269.99	$269.99

BIOSTAR's Hi-Fi H170S3H Board Is Aimed At Entertainment Builds

BIOSTAR has announced a new board for people building budget entertainment systems. The Hi-Fi H170S3H is based on Intel's H170 chipset, so you can use the latest Skylake processors, but you don't have access to as many PCIe lanes or connectivity ports as you do with the Z170. The board also supports DDR3L memory (max of 32GB DDR3L-1600), which helps if you're trying to stretch your dollar by making use of your existing memory. Another feature, BIO-Remote2, lets your Android or iOS devices act as a remote control for your system, a nice extra when building an HTPC.

GIGABYTE Adds Five New Graphics Cards To XTREME GAMING Series

GIGABYTE has added five more cards to its XTREME GAMING Series lineup, including Titan X, GTX 980, GTX 970, and two GTX 980 Ti models. For extreme overclockers pushing the envelope of performance, the two GTX 980 Ti cards include LN2 BIOS and an additional 6-pin PCIe power connector. All of the XTREME Series cards have a metal backplate and a special PCB coating that protects the cards from dust and moisture. Four of the cards feature WINDFORCE 3X air cooling, while one of the GTX 980 Ti cards has WATERFORCE liquid cooling.

EKWB Updates Dual-Bay Reservoir

EK Water Blocks has updated its dual-bay spin reservoir. The EK-DBAY Spin Reservoir (R3.0) has a spinning white impeller that shows when liquid is flowing through your system. (It's just an impeller, as the reservoir does not include a pump.) The reservoir is made mostly of POM Acetal with an aluminum bezel; an acrylic front lets you see the waterfall inside. There are four standard G1/4-inch ports on this model: three for outlets and one for an inlet. Two plugs come with the reservoir so you can block off open ports after deciding how you want to position your tubing. There's also one G3/8-inch port (and a plug for it) on top of the unit that you use to fill the reservoir with liquid.

EVGA Announces GQ Series PSUs

EVGA has a new series of power supplies for value-conscious users. GQ Series PSUs are 80 Plus Gold-certified and include some nice features such as high-quality Japanese capacitors and EVGA's ECO Intelligent Thermal Control system for the fan. The ECO control ensures the 135mm fluid dynamic bearing fan will only run when the PSU is above a preset load level. The single-rail PSUs come in four capacities: 650W, 750W, 850W, and 1,000W. They have a modular design so you can avoid unnecessary cable clutter and are ready for NVIDIA SLI as well as AMD CrossFire. The GQ Series PSUs are among the lowest-priced in EVGA's extensive lineup, with prices starting at $89.99.

ASUS Says More Predators Coming

ASUS says two new Predator displays, the XB271HU and XB271HK, will be available in time for the holidays. Both new monitors have flat screens that measure 27 inches, and like other Predator models, they come with NVIDIA G-SYNC technology. They also have Acer Eye Protect Technology, which includes features designed to reduce eye strain and fatigue during extended gaming sessions. The XB271HU has an IPS panel with WQHD (2,560 x 1,440) resolution. Response time is 4ms (gray to gray) and the refresh rate is a speedy 165Hz. The XB271HK features a 4K UHD (3,840 x 2,160) resolution at a 60Hz refresh rate. The IPS panel on this model also has a 4ms response time.

Deepcool Announces Dukase Case

Deepcool's new Dukase chassis is made of SPCC steel and ABS plastic and can hold ATX or smaller motherboards. It measures 504 x 213.4 x 482.7 mm (HxWxD). The front facade is made of metal and there are no drive slots or doors. The powder-coated case has a suspension-style design so you can quickly pop off the top for maintenance purposes to access fans or a reservoir. Inside the upper front of the case there's a movable bracket that holds two 5.25-inch drives and one 3.5-inch drive, plus there's room for two more 3.5-inch drives in the bottom of the case opposite the power supply. There also are mounting positions for two 2.5-inch SSDs and preset holes for mounting a third 2.5-inch SSD.

ASRock Adds Fatal1ty Z170 Board

ASRock has announced a premium Z170 motherboard that is positioned atop the rest of its gaming boards. The Fatal1ty Z170 Professional Gaming i7 motherboard is loaded with connectivity options and supports NVIDIA Quad SLI and AMD 3-way CrossFireX. ASRock says the board also is fully compatible with AMD FirePro and NVIDIA Quadro professional workstation graphics cards. The board is overclocking-friendly (it supports DDR4 to 3866+) and has a second external base clock generator that gives OC'ers more fine-tuned control when tweaking settings. ASRock also added extras to enhance gaming and protect components running at high speed settings for extended periods.

Cryorig Releases A Series Coolers

Cryorig's A Series hybrid liquid coolers combine a typical liquid-cooling setup with an extra fan mounted above the CPU. Cryorig says the addition of its adjustable Airflow fan drops the temperature of components in the area surrounding the CPU by up to 20%. The CPU water block and pump in the hybrid cooler are 5th Generation products from Asetek. Cryorig adds a radiator and its proprietary Airflow fan. There are three models in the A Series, and the size and type of the radiator determines the model name of the hybrid cooler. The A40 has a 240mm radiator, the A40 Ultimate has a 240mm radiator that is extra thick (1.5 inches), and the A80 has a 280mm radiator.

Israeli Company Works To Apply Deep Learning To Cybersecurity

There's no shortage of companies offering real-time detection and prevention of zero-day and advanced persistent threats. But Deep Instinct says it's the first company to apply deep learning to cybersecurity. Unlike some newer approaches, the company says, its tool offers proactive protection with "unprecedented accuracy in detection and real-time prevention." Deep Instinct can secure any device on any OS using a lightweight agent. It uses data fragmentation, breaking objects into their smallest parts, and applies deep learning to identify unknown suspicious behavior and detect, predict, and prevent known and unknown threats.

MIT Takes Mobile Image Processing To The Cloud & Back, Saving Power

More consumers are relying on smartphones as their primary cameras and their primary computers. But processing images on a smartphone can consume large amounts of bandwidth and battery power. Researchers at MIT, working with Stanford University and Adobe Systems, have demonstrated a system that can reduce bandwidth consumption by 98.5% and power consumption by 85%. The system relies on sending a highly compressed version of an image to a central server, which then processes the image and sends back an even smaller file with simple instructions for modifying the original image.

Former Opera CEO's New Browser Now Available For Beta Testing

In January, former Opera CEO and Founder Jon S. von Tetzchner previewed Vivaldi, a free Chromium-based Web browser constructed with power users in mind. It's now in beta. The release garnered early praise for a host of innovations the browser incorporates to distinguish itself from other browsers both in terms of look and execution. Vivaldi points out that the browser is unique because of its use of modern Web technologies, including JavaScript and React to create the user interface, and its user-driven customization abilities. "Because we're making it for you, we let you customize everything," the company states.
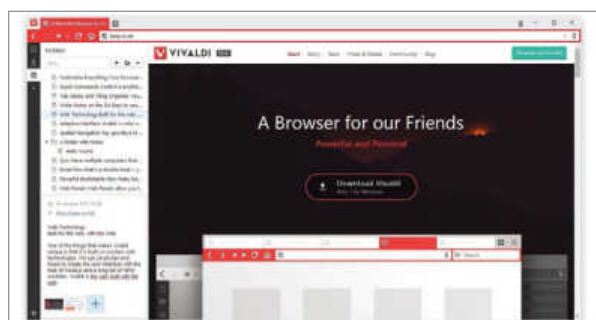
FlashPeak Slimjet Promises Faster, More Secure Browsing

There's no shortage of Web browsers promising fast, secure browsing with minimal fuss and no ads. But FlashPeak puts several unique features and touches in the newest version of its free Slimjet browser that may make it worth checking out. The browser's built-in ad blocker doesn't rely on a script-based extension interface that reduces performance because of the large number of ad-filtering rules. A turbocharged download manager can make multiple parallel connections to the server, boosting file download speed by up to 12 times. Plus, Slimjet offers advanced privacy and security protection.
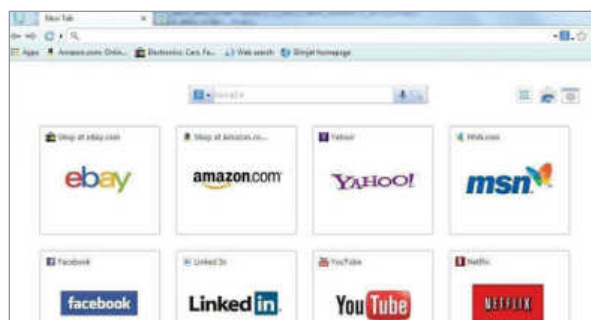
Microsoft Is Rewarding New Ideas For Last-Mile Technologies

If you have a great idea for bringing affordable Internet access to underserved markets and are a business with two or more employees, you might want to check out Microsoft's Affordable Access Initiative. The initative's grant program invests in new last-mile technologies, cloud-based services and applications, and business models that help more people affordably get online. Current projects include the deployment of TV white spaces and the Microsoft 4Afrika Initiative. Winners will receive about $75,000 in funding and free software and services and can connect with other grant recipients and potential funding.

Luma Builds A Wireless Network Customized To Your Home

Whether you live in a sprawling home or one-bedroom apartment, lots of things can block or weaken your Wi-Fi signal. That's the premise behind Luma. Depending on the space you live in, you'll purchase one or more of the Luma devices ($99 for one or $249 for three). Luma setup will provide advice on network optimization, including where to put each device for the best signal, and automatically connect the devices into a mesh network customized to your unique home. The resulting Surround WiFi network is smart enough to keep running at full speed all the time, all on its own.

Alphabet's Project Loon Balloons Are Headed To Indonesia

Project Loon, which is working to provide Internet access to the two-thirds of the world's population that doesn't have it, has its sights set on Indonesia, where just one-third of residents are connected to the Internet and even those connections are often painfully slow. Project Loon uses a network of balloons that travel on the edge of space—twice as high as airplanes and the weather. That type of network is particularly important in countries such as Indonesia, where connecting its more than 17,000 islands is challenging. Alphabet has signed agreements with three mobile network operators to begin testing next year.

UK Sets Plan For Broadband Access, Provides Connection Tips

British Prime Minister David Cameron outlined a plan to ensure every home and business in the country has access to 10Mbps broadband. As part of that, Ofcom, the country's regulator and competition authority for communications industries, is helping citizens test and improve their Wi-Fi signals. Ofcom's tips, which are applicable no matter where you live, include: keep your router as far away as possible from other electrical devices such as halogen lamps and dimmer switches; don't place your router on the floor; plug your router directly into the wall and avoid using extension cables; and use a broadband accelerator or filter device.

Job Of The Month

Looking for an overseas adventure, maybe something that would combine your love of all things Irish with your consummate tech skills? MasterCard, the folks who rejoice at the sound of cash registers ringing at this time of year, is looking for a manager of platform development—specifically, fraud platform development—in its Dublin office. Yes, this position leads the team that develops the tools that spot the bad guys when they're up to no good with pilfered credit cards. The person in this position works across dotted lines in the organizational chart, leading a team that communicates with other departments developing tools to protect consumers and businesses. Applicants should have previous leadership experience and the ability to work with multiple scrum development teams. The more Java development experience you have, the better, and you need to be able to "understand, embrace, and evangelize" the technical mission to others. Hey, you're a leader, so lead. If working on a global product in the land of the shamrock sounds like your pint of Guinness, see the company's website for more info.
*Source: www.mastercard.us*

We're No. 1 . . . Sorta

When it comes to computing technology, the United States is generally considered the world leader by a wide margin. On the latest listing of the 500 fastest supercomputers in the world by www.Top500.org, for example, the United States leads the way with 199 systems, while China is a distant second with 109. But while the United States can still claim overall computing superiority,

Countries With The Most Supercomputers In The Top 500

Country	Number
USA	199
CHINA	109
JAPAN	37
GERMANY	33
U.K.	18
FRANCE	18
INDIA	11
S. KOREA	9
RUSSIA	
SAUDI ARABIA	
OTHERS	52

China has some serious bragging rights of its own. For the sixth straight time on the semiannual listing, China's Tianhe-2 supercomputer has come in as the fastest supercomputer on the planet. Tianhe-2 is capable of 33.86 petaflops (quadrillions of calculations per second). That's almost twice as fast as the second-place U.S. Department Of Energy's Titan system, which clocks in at 17.59 petaflops.
Source: Top500.org
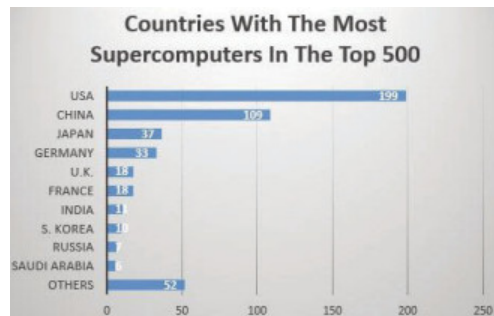
When I Grow Up, I Wanna Be A Race Car Driv . . . Er, A Football Pla . . . Um, I Mean I'm Gonna Play eSports

The interest in eSports and digital gaming continues to grow. Juniper Research says about 133 million people worldwide now subscribe to online eSports sites and services such as Twitch, and the market research firm expects that number to grow to more than 310 million in the next five years. The rapid growth rate is mirrored in revenue forecasts, which show eSports subscription revenues alone should generate about $1 billion annually by 2020. If the forecasts are accurate, eSports will soon have more fans than the ever-popular NFL football, approaching Formula 1 racing in popularity. Monday Night LoL Playoffs, anybody?

A Comparison Of Worldwide Fanbase Sizes
(Global Viewership Data From 2014)

eSports . . . . .102 million
NFL . . . . 220 million
Formula 1 Racing . . . . 400 million

Source: Juniper Research

Bring Tech Home For The Holidays

Intel Products To Help You Work, Play & Live Better

Your PC helps you do an awful lot, from working and filing your taxes to editing video, organizing photos, and mowing down waves of zombies. In most if not all of these cases, giving your PC the right tools to do the job can make a profound difference. A fast, efficient processor and an SSD can translate directly to a more responsive system, which in turn means you'll complete tasks more quickly and enjoy your leisure time all the more.

To that end, we present several products from Intel that are designed to help your PC perform as well as it can: Intel's Core i7 and Core i5 processors, and Intel SSDs. We'll also take a look at the Intel NUC and Intel Compute Stick, as they can handle a variety of computing tasks and take up very little space.

Core i7-5960X

Intel's Extreme Edition CPUs have been the benchmark for high-performance PCs for many years, and the Core i7-5960X is no exception. Formerly code-named "Haswell-E," this eight-core monster runs at 3GHz (with a Max Turbo frequency of 3.5GHz) and has a massive 20MB Intel Smart Cache. Thanks to Intel's Hyper-Threading technology, the processor is capable of handling a whopping 16 threads of instructions simultaneously, and does so with a TDP of just 140W.

The Core i7-5960X is also paired with Intel's X99 chipset and was from the first family of consumer CPUs to support today's fastest system memory, DDR4. This and other refinements add up to the fastest CPU on the market today, hands down, and its unlocked multiplier means that you can very easily make it even faster through overclocking. Simply pair it with a capable CPU cooler, such as Intel's own TS13X, and you are free to explore the 5960X's ample headroom.

Intel Core i7-5960X

More Haswell-E

If the X99 platform and the Haswell-E architecture appeals to you but you are on a somewhat tighter budget, Intel's Core i7-5930K and Core i7-5820K are options to keep in mind. These six-core, 12-thread CPUs have somewhat smaller amounts of Intel Smart Cache but also run at higher stock and Turbo frequencies. Both provide a wealth of computing power as well as support for the same quad-channel DDR4 memory that you'd pair with the Extreme Edition.

Intel Core i7-6700K

Core i7-6700K

Intel recently introduced its 6th Generation Core processors, code-named "Skylake." The flagship of this new family is the Core i7-6700K. This quad-core chip is the first consumer CPU built on a 14nm process, and the result is exceptional performance and unrivaled efficiency (the 6700K's TDP is a stingy 91 watts). Intel Hyper-Threading enables the chip to run up to eight concurrent instruction threads, and its 8MB Intel Smart Cache and 4GHz base frequency (4.2GHz Turbo) keep moving at blazing speeds.

The Core i7-6700K is designed to work hand-in-hand with Intel's newest motherboard chipset, Z170, and this means that the CPU is also the first non-Extreme Edition chip to support DDR4 memory, the fastest PC system memory available today. The Core i7-6700K and Z170 also provide support for the latest storage standards, including M.2, SATA Express, and U.2, so system builders can include the fastest SSDs on the market today (more on this in a moment).

Skylake Jr.

As with most Intel CPU families, the 6th Generation Core series of processors includes a more budget-friendly option in the form of the Core i5-6600K, a quad-core CPU that still benefits from Intel's new 14nm architecture and the Z170 chipset. This speedy processor runs at 3.5GHz (3.9GHz Turbo), and like the Core i7-6700K it has a fully unlocked multiplier, so overclocking is a snap.

SSD 750 Series

When building a system with one of the world's fastest processors and using the fastest available system memory, it really makes sense

to also include the fastest storage medium available. That means adding an SSD that utilizes the NVMe host interface and four lanes of PCIe 3.0, like Intel's SSD 750 Series.

These lightning-fast drives are available in two form factors, as a PCIe add-in card and as a 2.5-inch drive that connects to your PC via the U.2 interface. Regardless of which form factor you choose, you can get an Intel SSD 750 Series drive in one of three capacities (400GB, 800GB, and 1.2TB), and you will enjoy sequential 128KB reads up to 2,500MBps, sequential 128KB writes up to 1,200MBps, random 4KB reads up to 460,000IOPS, and random 4KB writes up to 290,000IOPS. (These numbers represent maximum speeds for the 1.2TB drives; speeds for other capacities vary.)

types. These versatile, dependable drives are available in both SATA 2.5-inch and M.2 form factors, and come in capacities ranging from 56GB to 360GB. Sequential 128KB reads and writes across the board can reach 540MBps and 490MBps, respectively, and random 4KB reads and write speeds vary by form factor and size but can reach 48,000IOPS and 80,000IOPS.

NUC

Intel's NUC (Next Unit of Computing) small form factor barebones PC is a tiny but powerful PC unit that provides lots of cool options like a VESA mount, a detachable lid that you can replace with your own custom 3D-printed lid, and more. Two recent NUC units in particular represent groundbreaking

The NUC5PGYH packs an Intel Braswell Pentium N3700 quad-core CPU with Intel HD Graphics that runs at 2.4GHz, as well as 2GB of DDR3L (you can expand up to 8GB), a 32GB eMMC on-board drive, and Microsoft Windows 10. It supports a full range of wired and wireless networking options, lets you add both a 2.5-inch SATA drive and SDXC flash memory cards, and provides the same USB 3.0 options as its Core i7 sibling.

Both units provide fast, quiet computing power for a variety of applications and (of course) a very small footprint for convenient placement in any room or setting. For more information on these and other NUC units, visit www.intel.com/nuc.

Intel SSD 750 Series

Intel NUC NUC5PGYH

Intel Compute Stick

SSD 730 Series

Available in both 240GB and 480GB capacities, Intel's SSD 730 Series drives represent the pinnacle of performance and reliability for SATA 6Gbps form factor drives, providing sequential 4KB reads up to 550MBps, sequential 4KB writes up to 470MBps, random 4KB reads up to 89,000IOPS, and random 4KB writes up to 74,000IOPS. (These numbers represent maximum speeds for the 480GB drive; 240GB drive speeds vary.) The drives also scale impressively when placed in two-drive RAID 0 configurations.

SSD 535 Series

Intel's SSD 535 Series drives are the perfect general-use solution drives for a host of system configurations and application

firsts: The NUC5i7RYH is the first barebones NUC unit powered by a Core i7 CPU, making it the highest-performing NUC ever, and the NUC5PGYH is the first NUC to come as a complete PC, with everything you need to plug in and get started right out of the box.

The NUC5i7RYH's dual-core Core i7-5557U processor runs at 3.1GHz (3.4GHz Turbo) and has a 4MB cache, as well as Iris Graphics 6100 and support for both HDMI and DisplayPort displays. It provides up to 7.1 surround sound, has four USB 3.0 ports (one of which is a charging port), and supports both wired Gigabit Ethernet connections and Wi-Fi 802.11ac and Bluetooth connectivity. Just add up to 16GB of DDR3L memory via two SODIMMs and a SATA 6Gbps SSD or hard drive, and you are ready to fire it up.

Compute Stick

The Intel Compute Stick is one of the smallest, most portable PCs available today. Roughly the size of a large flash memory drive, it lets you quickly transform any HDMI display into a PC that you can use for entertainment, productivity, digital signage, or a number of other applications.

This tiny unit includes a quad-core Intel Atom processor with Intel HD Graphics, 32GB of storage (Windows version), 2GB of memory, a USB 2.0 port and MicroSD card reader, and integrated Wi-Fi and Bluetooth. You can get a Compute Stick in both Windows and Ubuntu versions, and it's an incredibly convenient way to take your data and your personalized settings with you no matter where you go. Learn more at www.intel.com/computestick. ■

AION Poseidon

Last month, we took an in-depth look at the AION Mars, a mini-ITX system with custom liquid cooling. And while the Poseidon is also a member of the AION lineup, it's safe to say that this rig is a completely different, much bigger beast. Housed in an In Win 909 (an E-ATX chassis), the Poseidon is capable of quad-SLI and features your choice of Haswell-E processor. Liquid cooling is part of the package too, as is only befitting for a rig named after the god of the sea.

The Poseidon sent to us includes an Intel Core i7-5930K, three ASUS Strix GTX 980s (in 3-way SLI, of course), and 32GB of GeIL SUPER LUCE DDR4-2400. AION ran a custom liquid cooling loop through the CPU and GPUs, and boy, it's a doozy. The loop consists entirely of EK Water Blocks components, including a 360mm and a 240mm EK-CoolStream SE radiator, EVO Blood Red coolant, a tall reservoir, and full-cover water blocks on the ASUS Strix GTX 980s.

The top-notch EKWB hardware fits right in with the rest of the system's impressive components. After cooling off the processor, liquid coolant runs through the 360mm radiator and into the reservoir at the rear of the In Win 909 chassis. From there, coolant shoots through the GPU water blocks and is cooled by the 240mm radiator at the front of the chassis before returning to the CPU. Aesthetically, the radiators on the front and rear of the chassis nicely frame the cooling loop, and AION matches the

bend angles of the tubing coming in and out of the CPU and GPUs for a smooth, clean look.

We were also impressed by the artistry of the lighting effects inside the Poseidon. AION added bright red LED strips that pulse and provide brief glimpses of the internal hardware, as well as the coolant

passing through the loop. Red LEDs on the four GeIL SUPER LUCE modules also pulse, but the RAM LEDs aren't as bright and the tempo is based on each module's temperature, rather than the regular pattern of the LED strips. The dual pulsing effects produce an eye-pleasing, almost living look, for the internals behind the tempered glass side panel of In Win's 909. Even when the pulse illumination is dimmed, there's a dull red glow from the Thermaltake Riing

12 LED fans next to radiators and above the case's bottom vent.

The system interior is exceptionally clean. AION uses individually sleeved cables—red, of course—wrapped tightly together and neatly routed back to the PSU. There are lots of small details, such as customized GPU back plates and

Even under load, the AION Poseidon is barely audible.

a cover for the SLI bridge, that conceal any elements that might distract from hardware and loop, which also helps to create a cohesive, custom look. Touches like these show that AION has thought about making the Poseidon a showpiece build, which is something you don't see from every PC boutique.

Even under load, the AION Poseidon is barely audible. This is isn't particularly surprising, given the collection of quiet liquid cooling parts and near silent nature

AION's Poseidon possesses a wonderfully designed custom cooling loop, from the custom GPU water blocks to the matching bends on the tubing coming out of the GPUs and CPU.

AION Poseidon Benchmark Results	Stock	Over-clocked
3DMark Professional (Fire Strike Extreme)	**14299**	**14677**
Graphics Score	17723	17761
Physics Score	13990	16660
Graphics Test 1	95.55	95.42
Graphics Test 2	64.56	64.86
Physics Test	44.41	52.84
Combined Test	27.53	21.52
PCMark 8		
Creative Score	5680	6125
SiSoftware Sandra 2015 Processor Arithmetic		
Dhrystone Integer Native AVX2 (GIPS)	237.8	281
Whetstone Single-float Native AVX (GFLOPS)	119.41	174
Processor Multimedia (Mpixels/s)		
x32 Multimedia Integer AVX2	352.32	412
x16 Multimedia Long-int AVX2	178.5	210
x1 Multimedia Quad ALU	2.75	3.28
x16 Multimedia Single-float FMA	347.57	396
Memory Bandwidth		
Integer Memory Bandwidth B/F AVX/128 (GBps)	43.55	46.3
Floating Memory Bandwidth B/F AVX/128 (GBps)	45.71	47.82
Cinebench 15: CPU Score	1065	1254
Games 2,560 x 1,440		
Metro: LL (16XAF, SSAO Off)	83.3	95.5
Aliens vs. Predator (4XAA, 16XAF)	190.8	191.3
Dying Light (Med, AO On, AA On, Vsync Off)	95.9	99
The Witcher 3: (Vsync Off, Unl. FPS, Ultra)	58	59

of the Thermaltake Riing 12 LED fans. Still, it's noteworthy for enthusiasts who don't want a rig's noise to spoil their gaming sessions.

This Poseidon build is more than just a speedy CPU, loads of memory, and 3-way SLI. For storage, there are two 500GB Samsung 850 EVO SSDs set up in RAID 0, while a 1TB Western Digital Black HDD provides room for personal file collections. Wireless connectivity is available as well, thanks to the use of GIGABYTE's GA-X99-GAMING G1 WIFI motherboard. The build sent to us didn't include an optical drive, but options are available in the custom configurator should you want to add one.

By default, AION doesn't overclock the Poseidon, though the company tells us that OC service is available upon request for no additional charge at this time. We didn't request the option, but with such a powerful liquid cooling system onboard, we couldn't help ourselves and pushed the Core i7-5930K to 4.3GHz. Impressively, the Core i7-5930K barely got above 50 degrees Celsius under most loads.

The Poseidon handled our benchmarks like a champ. The 59fps in the Witcher 3, for example, is the highest we've seen on our test bench. The 3-way SLI configuration did great with Metro: Last Light (95.5fps) and Dying Light (99fps), too. The overclocked system reached nearly 2600 pixels per second in POV-Ray 3.7, so it clearly had no problem with processor-intensive duties. In the storage-centric CrystalDiskMark, the Poseidon's SSD RAID configuration delivered well above 900MBps sequential reads and writes.

The AION Poseidon displays both design precision and artistic creativity. If this particular build seems out of your price range, AION can scale the Posedion's components all the way down to $2,500, so you can enjoy the same attention to detail in a rig that fits your budget and performance needs. ■

BY NATHAN LAKE

Test system specs: Processor: Intel Core i7-5930K; Motherboard: GIGABYTE GA-X99-GAMING G1 WIFI; GPUs: ASUS STRIX-GTX980-DC20C-4GD5 (3-way SLI); RAM: 32GB GeIL's SUPER LUCE DDR4-2400; Storage: 500GB Samsung 850 EVO (x2, RAID 0), 1TB Western Digital Black; PSU: EVGA SuperNOVA 1300 G2; OS: Windows 10 Professional 64-bit

Nightblade X2-001BUS
$399.99
MSI
us.msi.com

MSI Nightblade X2

Many barebones PC kits feature an ultra-compact or exceptionally slim design that doesn't leave room for full-size graphics cards. The GPU limitations mean that most barebones kits are relegated to home office duty. MSI's Nightblade X2 is a different breed of barebones kit that supports a dual-slot GPU up to 290mm long—enough space to fit a GeForce GTX 980 Ti. With that said, we imagine power users who've built their own gaming rigs might question why someone wouldn't just pick all the off-the-shelf parts for complete control over what goes into the build. MSI designs the Nightblade X2 inside a compact mini-ITX case, so it's much smaller than a conventional gaming system. MSI also optimizes the layout and cooling to ensure peak performance. Accomplishing the same precision in a DIY build would require lengthy component consideration.

The "barebones" of the Nightblade X2 includes a mini-ITX case, a 500-watt PSU, a specially-built Z170 chipset motherboard, a slim-tray DVD burner, and a Killer Wireless-AC 1535 wireless adapter. The preassembled kit is a strong base configuration for a gaming rig. The

PSU, for instance, delivers enough juice for one high-end graphics card and meets the 80 PLUS Silver certification. We also like that the Z170 chipset supports up-and-coming hardware, such as DDR4 and PCIe SSDs, while also providing compatibility with Intel's new 6th generation Skylake processors.

The proprietary Z170 motherboard boasts some of the best onboard capabilities of MSI's GAMING motherboards. For example, it comes with a Killer E2400 NIC and its Advanced Stream Detect 2.0 network acceleration. Right out of the box, Advanced Stream Detect 2.0 monitors your network for game and multimedia traffic, and it prioritizes bandwidth to those applications above background programs. Within the Killer Network Manager, you can also customize traffic prioritization for individual programs installed on your PC.

The Nightblade X2 offers some mighty wireless capabilities, too, thanks to the built-in Killer Wireless-AC 1535 adapter. It supports the latest 802.11ac performance features, including MU-MIMO (Multi-User, Multiple Input, Multiple Output) and beamforming that can significantly improve signal range and

bandwidth—when used in conjunction with routers that support those features. Best of all, the Nightblade X2 supports Killer's Doubleshot Pro technology to assign network bandwidth to both the wired and wireless NICs. For example, you could devote the wired connection's bandwidth to your video game, while the wireless connection can handle your VoIP or game broadcast applications.

It's clear that MSI had power users in mind when designing the case. There's an OC Genie button the front panel to let you instantly overclock system internals, including the CPU. The front panel also features a USB 3.1 Type-C port, as well as two USB 2.0 ports for convenient mouse and keyboard connectivity. MSI even built a carrying handle into the case, so it's easy to tote into a LAN party.

To keep the system cool, MSI designed the Nightblade X2 so that cold outside air enters through the front and bottom vents, while hot air exits via vents in left side, rear, and top panels. Ideally, you'll want to select a GPU with an open-shroud heatsink, rather than the blower-style closed-shroud, because the GPU is located directly above the case's bottom vents. It's a perfect spot for pulling in

MSI designed the Nightblade X2 so that cold outside air enters through the front and bottom vents, while hot air exits via vents in left side, rear, and top panels.

cool air. A vent on the right side panel allows for the PSU to bring in cool air, as well. Beneath the left side panel vent, MSI provides a 120mm fan bracket for additional ventilation for system internals.

With the Nightblade X2's base in mind, you can now select your Skylake processor, CPU cooler, GPU, DDR4 memory, storage, and OS. The specialty Z170 motherboard features two DIMM slots where you can install up to 16GB of DDR4-2133. Storage options are plentiful. You can install up to two M.2 PCIe SSDs, two 2.5-inch drives, and one 3.5-inch HDD. One of the M.2 drives can be installed on the back side of the motherboard, while the other sits beneath the GPU. For the CPU cooler, a tower cooler is likely your best option, unless you want to modify the X2's side panel to hold a 120mm radiator. Based on our measurements, a heatsink/fan combo shouldn't be taller than six inches or wider than five inches to comfortable fit inside the Nightblade X2.

MSI sent us a Nightblade X2 decked out with an Intel Core I7-6700K, an MSI GTX 970 GAMING 4G, 8GB of SK Hynix DDR4-2133MHz, and Samsung's 128GB SM951. The seriously powerful mini-ITX build showed its stuff in our benchmark tests. For instance, support for Intel's flagship Skylake CPU allowed the Nightblade X2 to perform well in our processor-intensive tests. The rig posted a score of 851 points in Cinebench 15 and 1,884.98 pixels per second in POV-Ray 3.7. The inclusion of a GeForce GTX 970 makes this Nightblade X2 a great gamer, too, as it posted better than 30fps in all of our games tests—highlighted by 65fps in Dying Light. Those planning on adding speedy storage should take a peek at the CrystalDiskMark 5.0.2 benchmarks, which include an off-the-charts Sequential Read (Q32T1) rate of 1,956MBps.

If you're in the market for a compact PC and don't want to start the build process from scratch, the Nightblade X2 is an excellent starter kit. The price of $399.99 is right around what we'd expect to pay for Nightblade X2's provided hardware. We also like that power users still have the freedom to select the build's primary components. It's one of the few barebones kits we've seen that'll do for enthusiasts. ■

BY NATHAN LAKE

Benchmark Results	MSI Nightblade X2
3DMark Professional (Fire Strike Extreme)	**5074**
Graphics Score	5295
Physics Score	12830
Graphics Test 1	27.9
Graphics Test 2	19.6
Physics Test	40.73
Combined Test	10.64
PCMark 8	
Creative Score	5151
SiSoftware Sandra 2015 Processor Arithmetic	
Dhrystone Integer Native AVX2 (GIPS)	185.19
Whetstone Single-float Native AVX (GFLOPS)	111.23
Processor Multimedia (Mpixels/s)	
x32 Multimedia Integer AVX2	414.51
x16 Multimedia Long-int AVX2	193.28
x1 Multimedia Quad ALU	2.2
x16 Multimedia Single-float FMA	383.68
Games	**2,560 X 1,440**
Metro: LL (16XAF, SSAO Off)	53.5
Aliens vs. Predator (4XAA, 16XAF)	55.1
Dying Light (Med, AO On, AA On, Vsync Off)	65
The Witcher 3: (Vsync Off, Unl. FPS, Ultra)	37

Specs: Test system specs: Processor: Intel Core i7-6700K; Motherboard: Proprietary (Z170 chipset); GPU: MSI GTX 970 GAMING 4G; RAM: SK Hynix 8GB DDR4-2133 (HMA41GU6AFR8N); Storage 128GB Samsung SM951, 2TB Seagate Barracuda; Optical drive: Samsung SN-208; PSU: Proprietary (500 watts); OS: Windows 10 Home 64-bit

CONTOUR
$79.99
Tt eSPORTS
www.ttesports.com

Tt eSPORTS CONTOUR

The smartphone revolution was huge for gamers. No longer are we chained to a TV or PC monitor to get our gaming fix. And today's mobile devices are powerful enough to handle PC and console games from just a few years ago. In fact, you'd be hard pressed to find a major gaming franchise that hasn't made the leap to smartphones and tablets in one form or another (excluding, of course, first-party Nintendo franchises–we're still scratching our heads over that missed opportunity). But for those who're looking for anything more than a casual experience, touch-based controls are oftentimes maddeningly inaccurate and force you to cover the screen with your thumbs.

To make the most of your mobile gaming, you need buttons, joysticks, and something to hang onto. Thermaltake's iOS-compatible (iOS 7 or later) CONTOUR mobile gaming controller delivers all of these and then some, letting you move from crushing candy and drawing things with the tip of your finger to racing for pink slips, cappin' aliens, and embarking on epic adventures.

The black plastic controller features a matte finish and a red rubber-lined clamp for holding your phone. We managed to fit our iPhone 6 Plus, and the rather-thick case it features, between the adjustable pads, and it remained tight enough that the phone never felt like it would slip out. We also tried it with a smaller phone that features a 4-inch screen and it too was held fast. When you want to use it for an iPad, the clamp folds flush with the face of the device. There are X, Y, A, B buttons, two off-set joysticks, a directional pad, and a small pause button. There are two shoulder buttons and a pair of triggers, and the overall button layout will be instantly familiar to users accustomed to using an Xbox 360 or Xbox One controller.

The unit uses Bluetooth to communicate with your phone or tablet, and pairing it with our iPhone was a breeze. There's a built-in Lithium-ion battery that should last ten or more hours and four red LEDs on the face of the controller let you keep tabs on the remaining battery life. If you have Apple's Lightning Digital AV Adapter, you can even use your iOS-based device as a home console. The unit also works well with Apple TV, both the previous and current 4th Generation models.

The controller supports a dizzying number of games, but you can see if your favorite titles work by visiting http://bit.ly/1lxnb3M. We tested it out on Minecraft Pocket Edition, Bastion, and Star Wars: Knights Of The Old Republic and found the gaming experience to be vastly superior compared to using the touch controls. Not all functions were properly mapped to the CONTOUR's buttons, but this is a game-specific issue.

If you've kept mobile gaming at arm's length in the past due to shoddy touch-screen controls, check out the Thermaltake CONTOUR mobile gaming controller. It lets you enjoy a deeper and more satisfying gaming experience on the go. ∎

BY ANDREW LEIBMAN

Specs: Wireless mode: Bluetooth; Battery life (in-use, as advertised): 10+ hours; Compatible devices: iPhone 5 or newer, iPad Air (both models), iPad Mini (1/2/3), iPod Touch (5th Generation)

Commander FP
$12.99
Thermaltake
www.thermaltakeusa.com

Thermaltake Commander FP

A majority of the PC enclosures featured in *CPU* take component cooling seriously, and as such, feature mounts for half a dozen or more fans. Additionally, high-end motherboards tend to top out at about six or eight fan headers, which may lead you to believe that you'd never need more than that. And even if you do need a couple more, you could always get independently-powered fans and plug them directly into the PSU. Right? Enthusiasts know better. An all air-cooled case with multiple graphics cards and a high-end processor should have a series of top and side panel fans, in addition to multiple intake and exhaust fans in the front and back panels, respectively. Custom and closed loop liquid cooling setups also need banks of fans to keep those radiators cool.

There are two problems with using just the motherboard or the PSU to power and control your fans. If you fill those 3-pin or 4-pin headers on your motherboard, and add one or more additional fans using a 4-pin Molex connector, your meticulous wiring plans have just become an order of magnitude more complex. Secondly, any fan not plugged into a 4-pin PWM (pulse width modulation) header is just dumb, running at a static RPM regardless of how much heat there is to get rid of. At idle, these fans will be noisy, and under load, they won't be able to keep up. Your best option in these cases is to invest in a fan hub, and Thermaltake's Commander FP is one of the most affordable options around.

What's the big deal with PWM? In this context, PWM refers to the means of controlling your fan speeds in response to constantly changing temperatures. PWM as a control mechanism can effectively decrease the fan's duty cycle when temperatures are low, and increase the duty cycle when temperatures are high. The Commander FP uses temperature data reported by your motherboard. PWM is, hands down, the most efficient way to keep your vital components cool.

This diminutive fan hub comes with a pair of adhesive Velcro mounts that let you stick it to the back of the motherboard tray or behind the PSU to keep it out of sight. A single SATA power cable provides the requisite juice, and up to nine PWM-capable fans can be connected to the ports on either side of the unit. There's a single PWM signal connector coming from the Commander FP that you connect to a PWM-capable 4-pin fan header on your motherboard. There's a single port on the Commander FP that supports motherboard-based RPM signal detection, and it is denoted by a glossy portion of plastic adjacent to the port.

The Commander FP simplifies cable management by letting you route all of your fan cables to the out-of-sight hub, instead of plugging them all into the motherboard. The unit comes with five reusable beaded cable ties to bundle all those wires into neat groups. The unit also features a blue LED to let you know when it is powered.

Few accessories can simplify your wiring and make a dramatic improvement in your system's cooling efficiency. Perhaps best of all, the Commander FP does it for about the price of a ticket to the movies. ∎

BY ANDREW LEIBMAN

Specs: Dimensions: 0.7 x 3.2 x 1.7 inches (HxWxD); Connectors: 10 x 3-/4-pin (speed control not available via 3-pin connectors), SATA (power)

Fractal Design Node 202

Nowadays, HTPC cases come in a variety of shapes and sizes. On one hand, you have the tiny, handheld cases that are "big" enough for a computer on a card. On the other, you can go with a case so large that it lets you stuff a full-fledged high-end system inside. Fractal Design's Node 202 falls somewhere between these two extremes, but one thing is clear as soon as you unbox it: This case looks the part.

The Node 202 is roughly the same size as a current-gen videogame console. Its looks certainly fit in among the rest of your HTPC components, and thanks to the included stand, you can orient the case horizontally or vertically. The case itself consists of essentially two structures—the base, which holds all of your system's hardware, and a top shell that covers and contains everything. The shell has a steel top panel and plastic side panels, so the front of the case has a clean, matte finish. The base itself is primarily steel, making the whole chassis quite sturdy, and some plastic. Although there are no fans in the case itself, the Node 202 has vents strategically placed to allow ventilation for the hardware that needs it most (CPU, GPU, PSU). You wouldn't want to go crazy overclocking your components with this case, but we're not at all concerned that they'll overheat. All in all, the construction is solid, exactly what you'd expect from Fractal.

Inside the Node 202 is room to build a burly PC, but you also need to be aware of its limitations. First, you must use a Mini-ITX motherboard, which isn't a huge concern when you consider that there's a quality Mini-ITX motherboard available for any CPU you choose. Now, cooling that CPU is another matter. In order to fit inside the Node 202, the CPU cooler can't be taller than 2.2 inches, which limits you to a low-profile cooler (and even some of those will be too tall). You might be able to get away with a closed-loop liquid cooler, but that will force you to sacrifice the case's graphics card chamber in order to install the cooler's radiator. Our recommendation: Stick with a squat heatsink and fan.

Let's talk about that graphics card chamber, shall we? The Node 202 will hold one dual-slot graphics card up to 12.2 inches long, which is awesome, but the more significant restriction is the Node 202's included Integra SFX 450W power supply. The Integra still has enough juice to drive a pretty powerful graphics card. Conservatively, a GeForce GTX 960 falls under the Integra's 450W threshold, but you can probably get away with more as long as you stick with a quad-core CPU. In order to separate the graphics card in its own chamber, Fractal includes a riser cable that attaches to the graphics card's PCIe slot connector, threads through an opening in the Node 202's chamber partition, and then connects to the motherboard's PCIe x16 slot. We've seen this tactic used in other compact cases, and it works well here, as well.

Fractal also produces a Node 202 that doesn't include an Integra SFX 450W PSU. If you prefer this option, it will only set you back $79.99, but you'll still need an SFX form factor PSU that has a maximum length of 5.11 inches.

Some HTPCs barely have enough local storage for an operating system and thus function as streaming clients that pull content from networked storage or the Internet. At the opposite end of the spectrum are HTPCs that have enough local storage for a massive movie library. The Node 202 has a pair of 2.5-inch drive mounts, which will be enough for some, but those with massive media collections will probably need an external or networked storage option to supplement an HTPC built inside the case.

All that said, Fractal's Node 202 is a terrific foundation for an HTPC. It lets you install a lot of high-end components, and it will blend right in with the rest of your home theater gear. ∎

BY VINCE COGLEY

Node 202 (with Integra 450W SFX PSU)
$139.99
Fractal Design | www.fractal-design.com

Specs (case): Dimensions: 3.46 x 14.84 x 12.99 inches (HxWxD); Materials: Steel, plastic; Motherboard support: Mini-ITX; Drive bays: 2 x 2.5-inch internal; Fans (optional): 2 x 120mm bottom (GPU chamber); Ports: 2 x USB 3.0, audio I/O
Specs: (PSU): 80 PLUS Certification: Bronze; Maximum wattage: 450W at 50 C; 12V rails: 2 (18A each); 3.3V max: 21A; 5V max: 22A; Connectors: 1 x 20+4-pin ATX; 1 x 4+4-pin ATX12V; 2 x 6+2-pin PCIe; 2 x SATA; Warranty: 3 years

Aero-500 (Black or White)
$69.99
Aerocool
www.aerocool.us

Aerocool Aero-500

Aerocool is back with another one of its new Aero cases, which are part of the company's PGS A series. This case, the Aero-500, looks a lot like the Aero-800 (reviewed last month), which looks a lot like the Aero-1000 (reviewed in the June 2015 issue). Now before you convince yourself that you're seeing triple, realize that the Aero-500 differs from its fellow Aero cases in a few ways, so if the Aero-1000 and Aero-800 weren't quite what you were looking for, perhaps this impressive case is just what the enthusiast ordered.

The Aero-500 stands nearly as tall as the Aero-1000 and Aero-800, but it's not as long. From front to back, the Aero-500 measures 17.3 inches, 2 inches less than the Aero-1000 and almost an inch and half less than the Aero-800. Despite this, the Aero-500 doesn't run away from high-end hardware; you can still build a mighty fine rig with this chassis. First, you can install motherboards up to ATX inside the Aero-500, just like the other two Aero cases. Thanks to the positioning of the Aero-500's internal drive bays, there's enough room for two dual-slot graphics cards up to 14.7 inches long, and anyone who knows graphics cards can tell you that imposes few limitations on which cards you can install. The case supports CPU coolers up to 6.1 inches tall. You may have to mind the Aero-500's PSU clearance limit, though, which is a hair under 7.1 inches. Nevertheless, you can still find substantial power supplies that fall under this limit.

If you've read our previous Aero series case reviews, we really don't need to tell you that the Aero-500 is cosmetically very similar to the other two Aero cases (because you have eyes). The power and reset buttons, along with the USB ports and audio I/O, are located on the top panel, like the Aero-1000. A cool bonus that the Aero-500 throws into the mix is an integrated two-speed fan controller (right next to the power button), which is capable of supporting up to four fans in total.

Everywhere you look, you'll see evidence that Aerocool knows how to build a good case. Precut cable management holes are plentiful, and right where you need them. Dust filters on the top and bottom panels are removable, so cleaning them is a piece of cake. Like the other Aero cases, the Aero-500's top panel is recessed, letting you hang a 120mm or 240mm radiator without having to worry as much that the radiator will collide with your motherboard's VRM heatsinks. The case's drive bays accept 3.5-inch or 2.5-inch drives, and Aerocool even snuck a 2.5-inch drive mount behind the motherboard tray.

You want an intelligent, well-designed case that's loaded with builder-friendly features, but you don't want to pay a lot for it. We get it—spend on the major components and save on the case. Thankfully with the Aero-500, you can make a thrifty purchase without compromising on quality. ∎

BY VINCE COGLEY

Specs: Dimensions: 19.15 x 7.99 x 17.3 inches (HxWxD); Materials: Steel, plastic; Motherboard support: Mini-ITX, microATX, ATX; Drive bays: 2 x 5.25-inch external, 4 x 3.5-inch and 1 x 2.5-inch or 1 x 3.5-inch and 5 x 2.5-inch internal; Fans (included): 1 x 120mm rear; Fans (optional): 2 x 120mm front, 2 x 120mm top; Ports: 1 x USB 3.0, 2 x USB 2.0, audio I/O; Built-in fan controller

State-Of-The-Art Standards

NVMe

The physical components inside an SSD are more similar to system memory than the spinning magnetic platters in a hard drive. Yet for years, SSDs used the SATA bus and AHCI (Advanced Host Controller Interface) standard that were originally designed for hard drives. "NVMe (Non-Volatile Memory Express) is a protocol that was constructed specifically to unlock the full performance of flash memory," says David Allen, director of product marketing at PMC-Sierra. Compared to AHCI, for example, NVMe delivers much higher IOPs and lower latency. For these reasons and others, NVMe is beginning to look like the storage protocol of the future.

What Exactly Is NVMe?

You can think of NVMe as the software layer that provides a standardized interface for the storage drivers, command set, and SSD features. The NVMe protocol was defined by the members of NVM Express Work Group, which includes big names like Intel, Marvell, Microsoft, Micron, and Samsung. Overall, more than 80 companies participated in the development of NVMe.

"The reason NVMe came around was to improve the inefficiencies of ATA, which was originally designed for a much broader purpose and was used for SSDs simply because that's what was available," says Stan Yanitskiy, technical marketing engineer at PNY. "The NVMe protocol allows the system to take full advantage of an SSD's feature set and brings out the full potential of the functionality of an SSD."

NVM Express may very well overtake AHCI as the dominant storage protocol on your PC in the not-too-distant future.

NVMe works with the PCIe subsystem, rather than the SATA bus, which is one of the cornerstones of improving upon previous storage limitations. Leon Chen, business development manager at GIGABYTE, says, "With PCIe SSD performance benchmarks proving to be four times faster than what we've seen from 6Gbps SATA, the NVMe interface and protocol is definitely one to keep our eyes on."

"The reason NVMe came around was to improve the inefficiencies of ATA, which was originally designed for a much broader purpose and was used for SSDs simply because that's what was available." -Stan Yanitskiy

Intel's SSD 750 Series takes advantage of the NVMe protocol.

The PCIe bus has a lot to offer PC storage. "PCIe is overall faster than SATA, but it's also a bi-directional, or full-duplex, interface—which means that it can send reads and writes at the same time, whereas SATA can only read or write, not both (half-duplex)," says Yanitskiy. "PCIe also sits closer to the CPU and has more access to the computer's resources, whereas SATA generally sits behind a controller and is closed off from resources such as DRAM."

Modern NVMe-based storage devices use a PCIe 3.0 x4 pipeline, which provides a maximum bandwidth of 32Gbps—SATA can only deliver up to 6Gbps. As an added bonus, PCIe bus speed can scale to meet future improvements in flash and non-volatile memory by using PCIe x8 or PCIe x16 lanes. Over the latter, maximum bandwidth could reach 128Gbps, should future PCIe SSDs require such bandwidth.

The ability to scale also comes into play with form factors, capacity, and power. For instance, NVMe can be implemented into PCIe SSDs with add-in card, M.2, and 2.5-inch drive (currently via U.2) form factors. "M.2 offers a low-power and slim design that can hold a moderate amount of capacity, ideal for tablets and laptops, as well as small form factor desktops," says Allen. More storage capacity and power is available for add-in cards and 2.5-inch storage devices, so storage manufacturers can pick and choose which NVMe and PCIe SSD implementation works best.

A Better Mousetrap

Besides the faster performance of PCIe, most everything about the NVMe standard has been constructed to take advantage of the parallelism in today's processors, chipsets, and applications. NVMe supports a maximum queue depth of 64,000 and each queue supports an astounding 64,000 commands. With AHCI, there's only one

command queue, and it supports only 32 commands. "The drive will, of course, not use all of the 4 billion commands at once, but it helps remove limitations on the older interface," says Yanitskiy.

The deep command queue provides the NVMe protocol with a deeper pool when optimizing how read/write commands are arranged. AHCI's NCQ (Native Command Queuing) is a comparatively basic system that was designed let the hard drive execute a more latency aware sequence of read/writes to decrease the number of revolutions necessary to perform the command. And while AHCI's ability to queue up to 32 commands is helpful with SSDs, the parallelism is nowhere near what's available via the queue depth of NVMe.

The NVMe interface also allows data to be shared among multiple processing threads, so commands can be processed in parallel and independently of each other. AHCI doesn't allow resources to be shared among threads,

NVMe Driver Ecosystem is Strong

- NVMe drivers available on Windows*, Linux*, Solaris*, VMware*, UEFI
- Many are native / in-box drivers

Native NVMe drivers are in place for modern OSes, and add-on drivers are available for legacy OSes.

so a single CPU core or thread must handle the entire command. And if two or more threads or processors wish to access the same hardware port, a lock or other mechanism must be used to coordinate access. With NVMe, there's no lock necessary to maintain integrity, which keeps queue update overhead to a minimum. The end result is that NVMe supplies less overhead data than AHCI.

Maximizing IOPS & Latency

Some features of AHCI add latency to the storage interface. For example, ACHI requires four uncacheable register reads per command, and these each consume 2,000 CPU cycles and add 2.5 microseconds of latency. NVMe doesn't require any such register reads. The design further minimizes the number of writes to move commands and status queues, which reduces overhead and latency.

In general, NVMe requires fewer steps and commands to send the same amount of data. For example, NVMe can include 4K command

parameters in one fetch, while AHCI would use two serialized host DRAM fetches. "NVMe benefits from a storage stack that's more efficient, which reduces overhead," says Allen. The greater efficiency of NVMe makes for less drain on CPU power and more availability of CPU cycles generating I/O requests. With better IOPS than AHCI, NVMe drives quicker access to random data, so systems with PCIe

SSDs should feel even snappier than with a SATA SSD.

At a logical level, the NVMe programming interface can directly attach to either the chipset or CPU's PCIe lanes. The design is a big benefit for latency, Yanitskiy says, because "NVMe PCIe drives do not require an HBA, and interact directly with the CPU. SATA drives require an intermediary step between the drive and the CPU, which adds latency to the stack." The AHCI host interface also requires a lot of translation work when the controller and connected bus have to unpack and retransmit I/O requests.

Compared to NVMe, AHCI also offers limited scaling because the programming interface doesn't support interrupt steering and MSI-X (Message Signaled Interrupts Extended), which are in-band messages to direct commands. Experts have found that maximum IOPs for AHCI tops out at 200,000, while initial NVMe prototypes were measured at over 1,000,000IOPs.

Cores and Queues
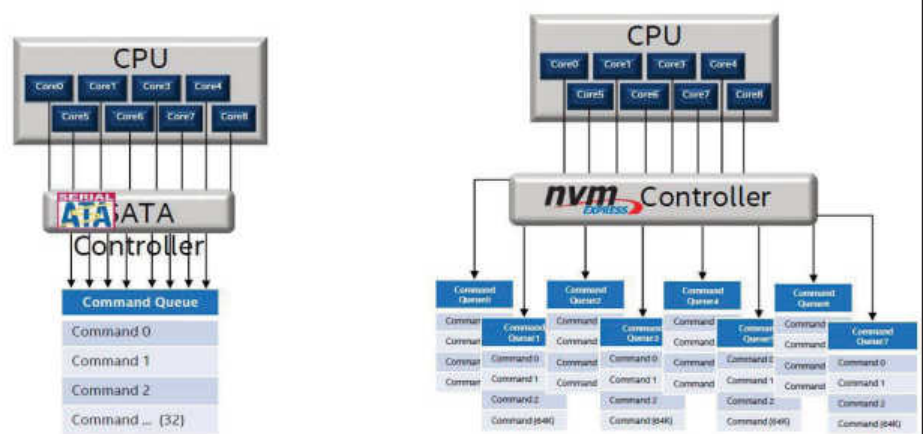
The NVMe controller is able to handle a much larger command queue than AHCI, which makes for faster I/O.

NMVe's interrupt handling is just another example of how the protocol overcomes AHCI limitations that restrict performance.

Note that it's possible for PCIe SSDs to operate using AHCI, but they will pay a performance penalty that will prevent them from reaching their full potential.

NVMe Is Smart

One of the most innovative elements of NVMe is its queue model, which is based on a system of command submission and completion queue pairs. NVMe's communications pathway allows multiple submission queues to be stored inside one completion queue, so commands don't need to wait on a single CPU core or thread to process all of the submissions.

MSI-X support helps out, too. An NVMe controller can use MSI-X to assign multiple interrupts and assign compute resources in the most efficient manner. To ensure necessary commands get through, NVMe supports priority access within the queue, so higher priority commands will skip ahead, rather than waiting in line. For example, an admin or urgent command queue can jump ahead of a queue labeled as medium or low priority.

A New Command Set

With AHCI, commands are processed over a series of data structures,

The NVMe protocol is designed to run over the PCIe bus.

and all commands are contained within a Command Table structure. The command set for AHCI is a huge list, and when defining the NVMe standard, designers opted for a completely new command set that left out much of the feature bloat and backward compatibility with legacy devices. "As an example, the

ATA command set consists of hundreds of commands, while NVMe whittles that down to 13 (depending on the revision)," says Yanitskiy.

The small command set is enough to utilize the speedier technology of non-volatile storage without burdening the I/O with extra commands that slow

NVMe PCIe SSDs are available as add-in cards, 2.5-inch drives, and M.2 SSDs.
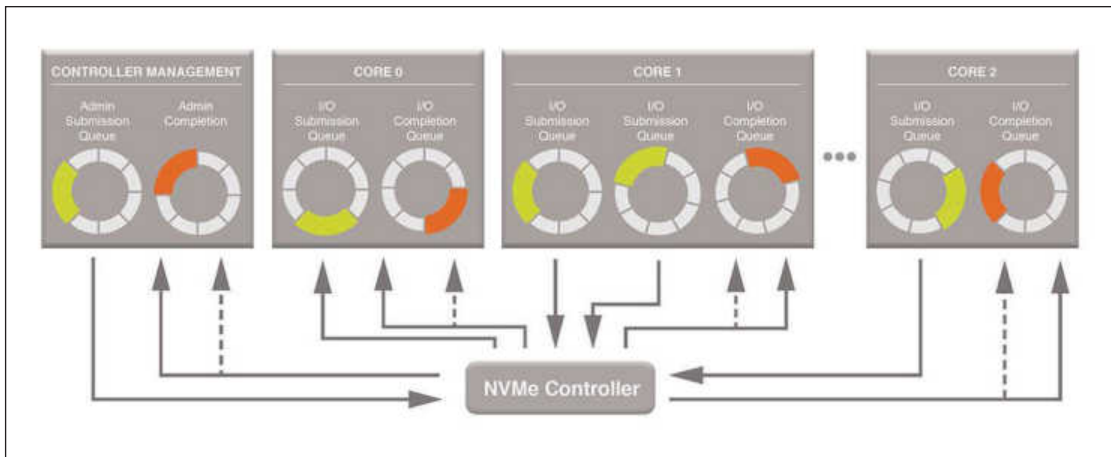
The NVMe protocol is based on a series of submission and completion queues, which can be processed among different CPU cores.

things down. For example, NVMe's 10 required Admin commands are simple items, such as Create I/O Submission Queue, Get Log Page, or Abort, while the three required I/O commands are Read, Write, and Flush. The design of the NVMe standard also allows for additional commands, should NVMe need to support a different types of technology in the future.

Namespace

With NVMe, storage can be divided among namespaces, which is a term for a quantity of non-volatile memory that's formatted and made visible to applications as a logical block. An NVMe controller can reference multiple namespaces via different logical ID names, so the OS would could see one drive as two logical partitions.

Creation and configuration of namespaces is currently vendor-specific, so namespace functionality will likely be limited early on with PCIe SSDs. If available, namespace management is something that might become useful for power users. It lets you create, delete, or resize a logical block, and you can attach or detach the storage from the controller. Within the namespace data structure, supported capabilities and settings can be created to let you manage which data gets written and read from the space.

NVMe & Future Technology

"There are many new and exciting non-volatile memory technologies coming to the pipeline that can take full advantage of the NVMe protocol," says Yanitskiy. "Right now, NVMe moves the bottleneck from the host interface (SATA) to the storage media interface—as the storage media continues to advance, the performance is only going to get better." As we are just starting to see PCIe SSDs for consumers, it's difficult to say how much faster the devices will get, but one thing is certain: PCIe SSDs over NVMe are dramatically faster than SATA SSDs over AHCI.

NVMe also brings along the possibility of speeding up everything you do on a PC. "There is a paradigm shift from SSDs simply being 'faster HDDs' to working directly with accelerating specific applications," says Yanitskiy. "We are already seeing real-time analytics and near-instant translation software, and as this technology develops it allows more and more to be done on the device rather than in the cloud." NVMe's ability to take advantage of parallelism and other tech advances should help application developers ring even more speed out of the PCIe bus in the future. ∎

Booting With NVMe

Windows 8.1 and Windows 10 include a native NVMe driver, so anyone with a recent Windows OS should be able to boot using PCIe NVMe SSDs. But if you're running Windows 7, you might have a problem, as Windows 7 doesn't support native UEFI booting without a Compatibility Support Module, UEFI firmware that allows booting by emulating a BIOS environment. And without an NVMe-aware BIOS, booting from an NVMe device with Windows 7 isn't likely possible. We've found that most motherboard makers have now released BIOS firmware updates for motherboards using the Z97, X99, and Z170 chipset. NVMe BIOS support for motherboards based on Intel's X79 and Z87 chipsets are not as common, and you'll need to check with the manufacturer. Support for AMD's 9 Series is even less sure, though some recently released models (such as MSI's 990FXA GAMING) do support NVMe. If you're planning on adding an NVMe PCIe SSD, we'd recommend an upgrade to Windows 10. After all, it's free another half-year or so, assuming you're running Windows 7 or Windows 8.1.

Get A Grip

Cooler Master's Xornet II & Sentinel III Give Gamers An Ideal Fit

How you hold your mouse could be holding you back. Specifically, a given mouse's body style usually accommodates one of two grip styles—palm or claw—and if your mouse's body style doesn't match your grip, you're putting yourself at a disadvantage before you make your first click. Whether you're after more overall comfort, better performance, or both, you ought to get a mouse that fits your mitt.

Cooler Master knows this, and that's why you'll find a horde of gaming mice that the company has tailored to each grip style. The Xornet II is a comfortable, colorful mouse that claw-grip gamers can use to excel in their game(s) of choice, and the Sentinel III harnesses Cooler Master's cutting-edge technologies in order to give palm-grip gamers a terrific experience. Both are excellent choices.

However, before we can put the right mouse in your hand, we have to establish what kind of hand we're putting it in. If your answer to the question "What

Cooler Master's Xornet II gaming mouse isn't for everyone, and that's actually a good thing. The Xornet II is designed to be both extremely comfortable and highly effective for gamers who use a claw-style grip to hold their mouse.

kind of mouse grip do you use?" is "the kind where I hold it," a little preliminary education is in order. So pay attention, padawans, because class is in session.

If you've modded everything else about your gaming setup, maybe it's time to consider modding your mouse grip. Between the palm grip (above left) and claw grip (above right), the palm grip is more natural, while the claw grip tends to let gamers click and move slightly faster. Cooler Master has plenty of gaming mice for either grip.

Perfect for palm-grip gamers, the Sentinel III feels great and is packed with customizability to let you tailor its performance and look according to your tastes.

MEGA MOUSE CLUB

Specs	Xornet II	Sentinel III
Grip type	Claw	Palm
Sensor	Avago 3320 (optical)	Avago 3988 (optical)
Max DPI	3,500dpi	6,400dpi
DPI presets	3	4
Tracking speed	80IPS/20g	200IPS/20g
Lift-off distance	<3mm (adjustable)	<2.1mm (adjustable)
Angle snapping	No	Yes
Polling rate	1,000Hz	1,000Hz
Onboard memory	8KB	512KB
Button profiles	N/A	5
Programmable buttons	7	8
Interface	USB 2.0	USB 2.0
Cable length	5.9ft.	5.9ft.
Weight	132g	155 to 177.5g
Additional weights	N/A	5 x 4.5g

Hands-On Learning

So much of the way we evaluate hardware boils down to comparing this number to that number, whether the comparison is a benchmark result or a particular specification, but this fixation on the quantitative doesn't always lend itself well to every type of hardware. As you can probably guess at this point, PC mice are one class of product that cannot be judged by numbers alone. DPI, tracking speed, polling rate, and so forth do tell us useful things about a mouse, but they don't say anything about how that mouse will feel in your hand or how it will perform based on your preferred grip style.

The palm grip consists of most of the entire hand making contact with the mouse body. The palm rests on the back half of the top of the mouse, and the entire index and middle fingers click their respective mouse buttons. With a palm grip, the forearm and wrist control mouse movement. The general consensus holds that a palm grip is the most natural way to hold and use a mouse.

The alternative grip, the claw grip, certainly sounds more ferocious. And indeed, lots of gamers believe that a claw grip yields performance benefits for competitors looking for any possible edge. You can identify a claw grip by its distinctive arched fingers, which leave only the fingertips to come in contact with the mouse buttons. Depending on hand size, a claw grip may also raise the palm itself above the body of the mouse. Holding a mouse with a claw grip usually lets gamers click mouse buttons faster, and it's easier to pick up and reposition the mouse without accidentally clicking a button. Despite these benefits, using a claw grip isn't natural (unless, maybe, you're a ThunderCat), so be prepared to experience a certain degree of discomfort and/or fatigue until you're able to adjust.

Despite the differences between these grip styles, we hesitate to recommend one over the other. Hand sizes vary, from doll-sized to ogre-sized, and that can influence optimal

grip, too. Take our in-depth examinations of the Xornet II and Sentinel III as examples of Cooler Master's extensive lineup of mice for both claw- and palm-grip gamers.

Xornet II: A Ferocious Claw-Grip Mouse

So, you've decided to try clawing your way victory. Perhaps you've been subconsciously using a claw grip for a while now and have just now looked down at your curled click fingers, wondering, "Why have I been using the wrong mouse for so long?" Either way, the time has come to get yourself a proper claw-grip mouse. The Xornet II has the right body style to let you stalk your prey with a claw grip, and it's designed with a bunch of features to help you be extra lethal and efficient.

Highlights of the Xornet II include an Avago 3320 optical sensor that has a DPI range of 500 to 3,500dpi. It has three customizable DPI presets (you can set each preset anywhere in the Xornet II's DPI

range, increasing or decreasing the DPI in 250dpi increments), and with dedicated buttons on the mouse, you can switch between them in a flash.

"On-the-fly DPI adjustment is just one extra step to give the user total control," says Alfredo Barroso, Cooler Master North American marketing specialist. "Depending on the game or weapon at hand, users may want to quickly adjust their sensitivity, and with dedicated DPI buttons, it's as simple as a quick click up or down."

Cooler Master cares about what goes into its mice beyond the optical sensor, which is why the Xornet II uses Omron switches for its main mouse buttons. As a comparison, consider the keyswitches found in a mechanical keyboard: They're designed to last longer, provide a better feel, and perform better than keyboards that use cheaper membrane switches. The Omron switches that the Xornet II uses have a 5 million-click life span and superior tactile feedback.

"The Omron switches housed in our mice are tested for the fastest and most tactile feeling, delivering a quick, crisp feeling to the user," Barroso says.

The Xornet II's excellent lift-off distance (LOD) of <3mm further distinguishes it from ordinary, bargain-basement mice. Hardcore gamers who regularly zip their mouse pointer across the screen likely understand LOD, but Barroso offers a simple explanation. "If you're a low sensitivity player, you have probably hit the edge of your mouse surface, making you pick the mouse to re-center it to get back into action," he says. "Your typical mouse will have a pretty high LOD, like 1 or 2 centimeters. Your quality gaming mouse will have an LOD of 3 millimeters or less. After that height, the mouse sensor will stop reporting to the computer, allowing you to freely move your mouse back to the mousepad without shifting the cursor. In short, the lower the LOD, the better." Like the rest of the Xornet II's features, its LOD is also customizable.

Sentinel III: Supercharged For Palm-Grip Gamers

The Sentinel III shares many qualities with the Xornet II—Avago optical sensor, Omron switches, ultra-low LOD—but on

the former, everything is cranked up, way up. The Sentinel III uses an Avago 3988 sensor, which actually extends its maximum DPI to 6,400dpi and gives you four preset DPI levels. The Omron switches in the Sentinel III are good for at least 20 million clicks, and its LOD is <2.1mm. Like the Xornet II, the Sentinel III's DPI presets and LOD are user-configurable.

The Sentinel III's bag of tricks is larger than that, too. Thanks to the mouse's built-in 512KB of memory, it gives you five button configuration profiles, letting you optimize the Sentinel III's button mapping and settings for different games without having to reconfigure it every time you switch games. By using the Sentinel III's OLED display, you can tweak many of its settings (on-the-fly DPI, LOD, etc.) without jumping into its configuration software. And beyond the mouse's sensor and button settings, you can even configure its physical profile. On the base of the Sentinel III beneath a pry-off panel, you'll find a set of five removable 4.5g weights, giving the mouse a mass range of 155g to 177.5g. When

the fulcrum between victory and defeat is a fraction of a second, every little bit of customizability helps.

Colors Galore

After switching between the DPI presets of either mouse, you'll immediately notice the LEDs changing color. Obviously, the Xornet II's and Sentinel III's lighting is there to look cool, and you can define "cool" however you want. By dialing in the each RGB light from 0 to 255, you have a palette of 16.8 million colors to choose from. Lighting effects, including Breathing and Rapid Fire (the latter of which causes the LED light flicker between white and your custom color every time you click a button), let you personalize each mouse even further.

Grip It & Rip It

Ultimately, how you hold your mouse should be a personal decision. If you love using a palm grip, sacrificing that comfort for the few extra clicks per minute a claw grip might afford likely isn't the best tradeoff. With the Xornet II and Sentinel III, Cooler Master is here to lend your hand a hand. ∎
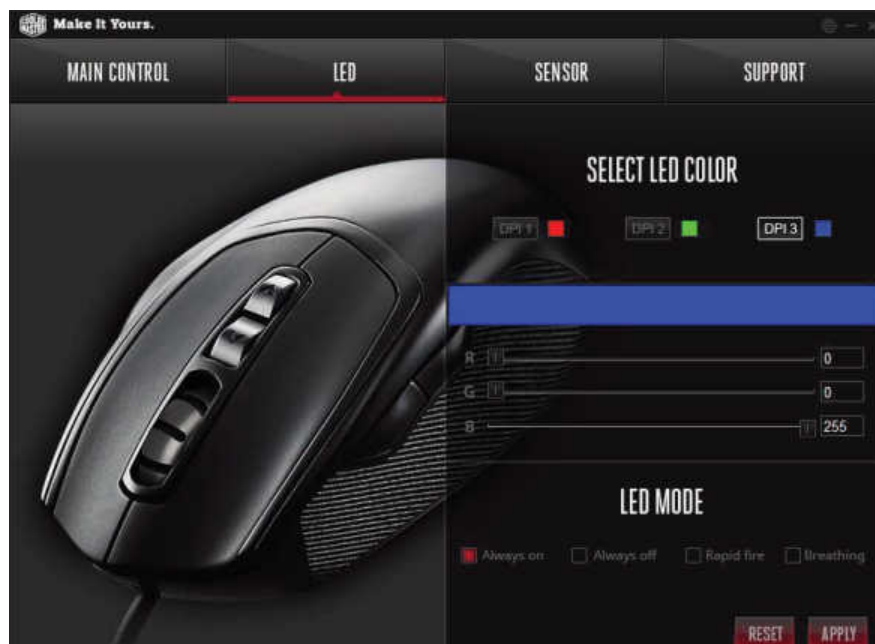
Think of Cooler Master's customization software for the Xornet II and Sentinel III as an extensive control panel capable of tweaking dozens of settings. With it, you can remap mouse buttons, change the DPI presets, configure the sensitivity, set the LEDs to perfectly match your system's colors, and more.

2015 Holiday Gift Guide

You won't find any fruitcake here, only enthusiast tech. From practical to luxurious, our gift guide is filled with ideas for your wish list, as well as presents for fellow power users.

We love that enthusiasts are selective about the tech they use, because we're the same way. Those same qualities can also make gift giving rather stressful for non-techie family members and friends. A helpful suggestion or two can help you avoid being stuck yet again with a sweater that you will never wear. For those planning a build, there are motherboards, cases, and graphics cards, as well as a power supply and an SSD. If you'd prefer something that's closer to a finished product, there are several barebones kits to peruse, including some small form factor PCs that could find a home near your entertainment center.

You'll find plenty of accessories that would be compatible with most any setup, as well. There's a gaming mouse, a monitor, a wireless range extender, a gaming chair, and an add-on microphone. Looking for something to enhance mobile device functionality? There's an exceptional mobile gaming controller, as well as a Bluetooth speaker that doubles as a powerbank. A number of the gift guide options make for great stocking stuffers, if you're in need of some tiny tech. Happy hunting!

MSI Z170A GAMING M7

$229.99 • Us.msi.com

The Z170A GAMING M7 is filled with some of MSI's best additions to the Z170 chipset. It includes DDR4 Boost technology that allows for DDR4 clocked at up to 3,600MHz, as well as support for next-generation storage (two M.2 ports and two SATA Express ports). There are also plenty of onboard overclocking extras, such as voltage check points and a debug LED. High-fidelity audio is onboard, too, thanks to MSI's Audio Boost 3. This collection of audio hardware is powered by Nahimic Sound Technology, where you can create profiles for Music, Gaming, and Movies. Within each profile, you can adjust the intensity of bass, reverb, and voice clarity, as well as turn on or off the virtual surround sound.

MSI includes a license for Xsplit Gamecaster, so you can broadcast your games like the pros. The rear panel connectivity is impressive, too. There are two USB 3.1 ports; one is a reversible Type-C connector and the other is the standard Type-A port. MSI also includes a BIOS flashback port where you can connect a flash drive with the latest MSI BIOS and update your PC without a CPU or memory installed. It's certainly a gift that enthusiasts will appreciate.

THE PERFECT GIFT FOR: ***POWER USERS BUILDING A GAMING PC THAT CAN ACHIEVE SUPERB OVERCLOCKS.***

AntLion Audio ModMic 4.0

$49.95 • www.modmic.com
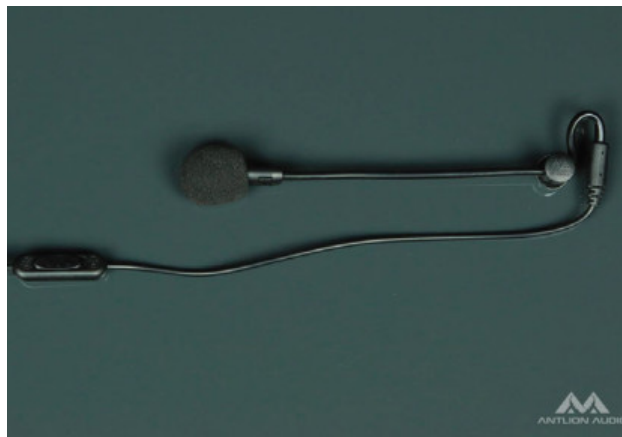
We included the ModMic in last year's gift guide, and it's still a fantastic present for enthusiasts. The add-on microphone lets you or your gift recipient transform a pair of headphones into a headset. Just stick the ModMic onto the right or left side of the headset and plug the cable into the PC or console's microphone input. Audiophiles picky about their voice quality will like that the ModMic is a uni-directional microphone with a sensitivity of -38dB and a frequency response from 100Hz to 10kHz.

The ModMic connects to your headset via a pair of small, magnetic clasps. When you want to remove the microphone, just pull it away the base clasp. It reattaches just as easily. The ModMic's boom is moldable, so you can bend and position it exactly where you want it. You can also adjust the boom's length by sliding the clasp along the boom until you find the most suitable extension. A convenient case is included, too, so you can travel with the microphone detached from the headset.

THE PERFECT GIFT FOR: ***THOSE WHO WANT TO TURN THE HEADPHONES THEY LOVE INTO THE HEADSET THEY LOVE.***

Intel 240GB SSD 535 Series

$119.99 • www.intel.com

With PCIe SSDs on the way, SATA SSDs have become much more affordable, and if you've got a tech-lover in your family, Intel's SSD 535 Series might just be the perfect stocking stuffer. We've found the 240GB capacity model available for just over $100, and it delivers sequential reads and writes up to 540MBps and 490MBps, respectively. For such an affordable drive, it also produces impressive random 4KB reads and writes of 41,000 IOPS and 80,000 IOPS.

Intel's SSDs have long been known for reliability, as well as low power consumption (Intel rates this drive with an active power of 165mW), so they are ideal additions to a notebook—especially one that might still be booting off an HDD. Gift recipients who are concerned about data security will like that the SSD 535 Series supports AES 256-bit data encryption, as well as end-to-end data protection. The SSD 530 Series is also compatible with Intel's exceptional storage utilities, including the Intel SSD Toolbox with Intel SSD Optimizer, Intel Data Migration Software, and Intel Rapid Storage Technology.

THE PERFECT GIFT FOR: ***ANYONE WITH A PC THAT COULD BENEFIT FROM A SPEEDY, RELIABLE SSD.***

LEPA BTS02

$79.99 • www.lepatek.com

From its outward appearance, you can probably guess that the BTS02 is a portable Bluetooth speaker. And while it does serve this role, the BTS02 is also a powerbank with a 2,200mAh capacity, as well as an audio conference tool, thanks to the built-in omnidirectional microphone. When blasting your tunes, the BTS02 won't be easily drowned out. LEPA rates it for a maximum sound level of 90dBA. After all, why bring a portable speaker to the beach if it's only going to be muffled by your neighbor's truck speakers? Speaking of the beach, LEPA outfits the BTS02 with a silicone rubber that offers IP54-rated water resistance, which provides protection against splashing water.

Should you want to hear the BTS02 on-the-go, LEPA includes a stainless steel hook that's perfect for strapping the Bluetooth speaker to a backpack or bag. The BTS02's rechargeable battery can deliver up to 10 hours of playtime. An aux-in port is available, too, if you wish to connect a device without Bluetooth capability, such as a legacy iPod.

THE PERFECT GIFT FOR: ***FRIENDS THAT WANT TO A WAY TO BETTER ENJOY MUSIC FROM THEIR MOBILE DEVICES WHEN ON-THE-GO, AS WELL AS PORTABLE POWER TO CHARGE MOBILE DEVICES.***

GIGABYTE GV-N970XTREME-4GD

$379.99 • www.gigabyte.us

GIGABYTE's lineup of EXTREME GAMING cards shows off impressive feats of engineering. The GV-N970XTREME-4GD, for example, represents one of the highest factory overclocks you'll see on a GeForce GTX 970. GIGAYBTE cranks the base clock up to 1,190MHz (NVIDIA reference is 1,050MHz) and the boost clock to 1,342MHz (NVIDIA reference is 1,178MHz). In addition to the speedy overclock, GIGABYTE also improves the card's aesthetics with RGB LEDs in the cooling fans and under the WINDFORCE emblem. You can customize both the LED color and lighting effects via GIGABYTE's OC GURU II utility.

For stability under load, GIGABYTE uses 10+2 power phases on the GV-N970XTREME-4GD, which helps to lower MOSFET temperatures while also providing the GPU with more reliable voltage output. The chokes and capacitors offer the same high-grade power handling as the powerful Titan X, too. GIGABYTE extends the life of the card by applying a breathable aerospace-grade coating to the PCB, which shields against moisture, dust, and corrosion.

THE PERFECT GIFT FOR: ***GAMERS WANTING A GRAPHICS CARD WITH A SUBSTANTIAL FACTORY OVERCLOCK FOR THE SMOOTHEST POSSIBLE GAMEPLAY.***

ASUS MG279Q

$599 • www.asus.com

Designed for gamers, the MG279Q is a 27-inch monitor that brings together the incredible image fidelity of IPS panel technology with support for AMD FreeSync and a 144Hz refresh rate. The end result of all this fancy tech is a display with spectacular color reproduction that virtual eliminates motion blur and screen tearing. If exceptional detail is more your thing, you'll like that the MG279Q boasts a native resolution of 2,560 x 1,440—for a pixel density of 109 pixels per inch. ASUS indicates that the WQHD resolution provides up to 77% more onscreen space than a standard 1,920 x 1,080 display. To avoid streaks and ghosting, the MG279Q offers a 4ms response time. In addition to the visual enhancements, ASUS includes its GamePlus hotkeys to give gamers a competitive edge. There's a customizable on-screen timer, ideal for knowing when exactly you need to camp spawn points, and a crosshair overlay to perfect aim. ASUS provides six preset display modes, so you can switch among optimized visual modes for various game genres and multimedia. For your viewing comfort, the MG279Q tilts vertically, swivels horizontally, pivots up to 90 degrees clockwise, and is height adjustable from 0 to 150mm.

THE PERFECT GIFT FOR: ***ANYONE WHO VALUES AN EXCEPTIONAL VISUAL EXPERIENCE WHEN USING THEIR PC.***

Intel NUC5i7RYH

$499.99 • www.intel.com

Intel's 5th Generation Broadwell-U chips offer outstanding on-die graphics performance and much lower power consumption than Intel's 4th Generation processors, and the NUC5i7RYH boasts one of the most powerful Broadwell-U chips, the Core i7-5557U. If you're not familiar with these miniature PCs, Intel's NUC lineup is a barebones kit that delivers desktop PC-like functionality from a device that's only slightly bigger than a hockey puck. The Core i7-5557U is a dual-core CPU with 3.1GHz base frequency (3.4GHz Turbo) and Intel Iris Graphics 6100. The latter is propped up by 48 execution units – 24 more than what you'll find on the 6th Generation's flagship desktop chip.

For connectivity, the NUC5i7RYH includes Mini HDMI and Mini DisplayPort outputs, as well as four USB 3.0 ports, Gigabit Ethernet, Wi-Fi, and Bluetooth. Your gift recipient just needs to add storage (via an M.2 SSD or a 2.5-inch drive), DDR3L memory, and an OS. With more power than ever for gaming and content creation, Intel's latest NUCs are ready for whatever you require of them.

THE PERFECT GIFT FOR: *PEOPLE WHO NEED A MINIATURE DESKTOP COMPUTER THAT'S USEFUL FOR ALL TYPES OF DUTIES.*

MSI GTX 970 GAMING 4G

$347.99 • us.msi.com

With nearly 500 reviews on Newegg, MSI's GTX 970 GAMING 4G is one of the most popular GeForce GTX 970 cards out there. MSI configures this card to run in one of several modes, including two with speedy factory overclocks. The Silent Mode, as you might guess, is the slowest and offers a base clock of 1,051MHz and a boost clock of 1,178MHz. The Gaming Mode jumps those numbers up to 1,114MHz and 1,253MHz, respectively. The OC Mode delivers the best performance and reaches a base clock of 1,140MHz and a boost clock of 1,279MHz.

Part of the reason MSI is able to hit these lofty overclocks is the Twin Frozr V cooler, which features a massive, nickel-plated copper base that's combined with heatpipes and fins to pull heat away from the GPU. When temperatures are low, such as during idle, the Twin Frozr V's fans won't spin to eliminate noise. Of course, the GTX 970 GAMING 4G ramps up fan rpms when necessary. The GTX 970 GAMING 4G offers two DVI outputs (one DVI-I and one DVI-D), an HDMI output, and a DisplayPort output. Both the HDMI and DisplayPort connections support 4K video resolutions.

THE PERFECT GIFT FOR: *GAMERS THAT WANT A FULLY OPTIMIZED GEFORCE GTX 970.*

ASUS RP-AC56

$99.99 • www.asus.com

Not everyone is ready to commit to a full network rebuild to combat Wi-Fi deadzones. Range extenders are a great option for folks looking to enhance throughput and coverage without having to have technical expertise or drop $300 on a high-end router (though ASUS does make some top notch routers). The ASUS RP-AC56 is a dual-band range extender that can deliver up to 300Mbps over the 2.4GHz band and 867Mbps over the 5GHz band. Signal quality LEDs on the RP-AC56 help you to find a location that delivers the best connection with your router. To further boost performance, ASUS packs its ExpressWay technology that lets the RP-AC56 dedicate one band for the router connection and another for speeding data to your device. ExpressWay is ideal for data-intensive duties, such as streaming HD quality video. For ExpressWay to work, you'll just need a router or at least one device to support the 5GHz band. A Normal mode (where the RP-AC56 uses both bands simultaneously) is also onboard for those who want the best compatibility. The RP-AC56 also features roaming assist, so you won't need to manually disconnect from the router in order to connect to the repeater.

THE PERFECT GIFT FOR: ***FRIENDS AND FAMILY WHO NEED A MORE RELIABLE, SPEEDY WIRELESS NETWORK.***

Tt eSPORTS Contour Mobile Gaming Controller

$79.99 • www.ttesports.com

The increasing quality of mobile games makes them appealing for hardcore gamers, but a smartphone or tablet's onscreen controls can still be a real gum-in-the-works. The Contour Mobile Gaming Controller brings console-like control for iOS devices, including iPhones, iPads, and the 4th Generation Apple TV. It connects to your iOS devices via Bluetooth and features an adjustable clip with rubber tabs to lock in your device. You'll find pretty much all the buttons, sticks, and triggers found on a modern console controller. For instance, there are dual, clickable analog sticks, shoulder buttons, and shoulder triggers, as well as a D-pad and action buttons (XYAB). The fluid controls allow for precise in-game movements and the variety of buttons offers greater flexibility with actions. Tt eSPORTS rates the Contour Mobile Gaming Controller with a 10 hour battery life, too. The comfortable grip ensures that your hands won't cramp up during all-day gaming sessions. Hundreds of titles work perfectly with the console-style Contour Mobile Gaming Controller, and you can visit Tt eSPORTS to see a complete list of supported games.

THE PERFECT GIFT FOR: ***MOBILE GAMERS WHO WANT MORE PRECISION AND CONTROL WHEN GAMING WITH THEIR IOS DEVICES.***

DXRacer OH/RE128/NWGO/COD

$379 • www.dxracer.com

Call Of Duty: Black Ops III introduces a new breed of superhuman warfighters, and like your in-game character, you might benefit from a tool that lets you move faster and better interface with computers. And while it's not cybernetic, this special edition DXRacer chair comes with a custom Call Of Duty: Black Ops III theme, which includes the franchise's imposing skull logo on the back of the chair. The OH/RE128/NWGO/COD is more than just a cool way to represent the COD brand, as the chair also delivers the comfort and ergonomics that have made DXRacer a favorite of gamers around the world.

The backrest take cues from the company's race car seats to fully support your spinal column and prevent stiffness during long gaming sessions. There's both a headrest and lumbar cushion, too, if you want to customize the backrest's padding. Almost every aspect of the chair is adjustable, including arm height, seat height, backrest angle, and seat angle. For easy movement, the strong five-point base includes two-inch castor wheels. The sleek polyurethane cover offers top-notch durability and a luxurious, soft feel. It all adds up to making you a better class of COD soldier.

THE PERFECT GIFT FOR: ***CALL OF DUTY PLAYERS THAT WANT TO GAME IN ULTIMATE COMFORT.***

PBA Rogue-Z Special Edition by NCIX PC

Starts at $1,999.99 • www.ncixpc.com

NCIX PC offers some fantastic, finely tuned special edition systems, and the PBA Rogue-Z Special Edition is the company's latest creation. It's a powerful gaming rig built around Corsair's soon-to-be-released Carbide 600C chassis and several ASUS components. For example, starting configurations include an ASUS ROG MAXIMUS VIII Ranger motherboard and ASUS Strix GeForce graphics cards. With the latter, you can choose among the Strix GeForce GTX 970 4GB, the Strix GeForce GTX 980 4GB, and Strix GeForce 980 Ti. Similar to NCIX PC's other boutique rigs, you'll be able to customize the system to suit your performance and budget needs. The PBA Rogue-Z Special Edition is full of detail work that's sure to impress, including individually-sleeved power cables and brilliant LED illumination. The Carbide Clear 600C is the perfect vessel to display the elegant system internals. There's a huge side-panel window, and the case features an inverted ATX layout, so you'll get a whole new view of the rig's hardware. Customers requiring even more performance can request the Turbo Hydro Package, which adds a custom liquid cooling loop for the CPU and GPUs designed with EK Water Blocks components.

THE PERFECT GIFT FOR: **ENTHUSIASTS THAT WANT A GAMING RIG MADE WITH BOUTIQUE CRAFTSMANSHIP.**

GIGABYTE GA-Z170X-GAMING 7

$219.99 • www.gigabyte.us

Are you planning a Skylake-based build in the near future? What better way to fill out your wish list than with a motherboard that boasts some of the best available onboard audio and networking, as well as the serious support for next-gen connectivity? The GIGABYTE GA-Z170X-GAMING 7 features a Thunderbolt 3 port, Intel and Killer NICs, and audio powered by Creative's Sound Core 3D chip. For next-generation storage, there are two M.2 ports that each support up to 32Gbps, as well as three SATA Express connectors. Gamers will like that this board supports 2-way SLI and 3-way Crossfire, and each of the PCIe x16 slots is reinforced with stainless steel shielding. You can achieve precise overclocks thanks to GIGABYTE's TURBO B-Clock Tuning IC that lets you adjust the BLCK strap 1MHz at a time, rather than the 5% range of traditional straps. GIGABYTE uses a sharp white and red color scheme over the black PCB that will draw the eye of anyone looking inside your build. Clearly, it's a solid base for any future build.

THE PERFECT GIFT FOR: *GAMERS WANTING A MOTHERBOARD WITH PREMIUM ONBOARD AUDIO, NETWORKING, AND CONNECTIVITY FOR AN UPCOMING SKYLAKE BUILD.*

Cooler Master Ergostand III

$49.99 • www.coolermaster.com

A gaming laptop often does double duty as a desktop replacement PC during work hours. A laptop's screen, though, isn't as adjustable as a traditional monitor and makes for an uncomfortable workstation when used as the primary display. Cooler Master's Ergostand III offers six height settings, so you or your gift recipient can customize the viewing angle. To help cool the laptop, Cooler Master also includes a 230mm fan with a blade design that concentrates airflow into the middle of the stand, rather than moving it out in all directions. The Ergostand III's fan can move 72cfm, while only generating a noise level of 21dBA, which is probably quieter than your laptop's internal fans. Should you find the stand's fan noise to be too loud, you can adjust the built-in fan speed dial and lower or raise fan rpm as necessary. For quick dust removal, the Ergostand III features a detachable mesh plate. And last, but not least, Cooler Master adds a four port USB hub that expands peripheral connectivity.

THE PERFECT GIFT FOR: *THOSE WITH A DESKTOP REPLACEMENT LAPTOP THAT COULD BENEFIT FROM BETTER COOLING, A CUSTOMIZABLE VIEWING ANGLE, AND INCREASED CONNECTIVITY.*

GIGABYTE BRIX GB-BXi7-5500

$556.99 • www.gigabyte.us

BRIX ultra-compact PCs are really quite astounding, as they channel the capabilities of an affordable desktop computer into a small, sophisticated package. The miniature design allows the computer to better blend into modern settings and expands the potential use cases. Think a discrete home theater PC, for example. The GIGABYTE BXi7-5500 is a barebones kit that includes Intel's Core i7-5500U (2.4GHz base frequency and 3GHz Turbo). GIGABYTE also loads up the GB-BXi7-5500 with wireless connectivity via an 802.11ac/Bluetooth 4.0 combo module. It can pair with wireless devices via NFC, too.

To optimize your productivity, the GB-BXi7-5500 supports dual displays via the HDMI and Mini DisplayPort outputs. GIGABYTE also manages to include four USB 3.0 ports (two front, two rear) and an Ethernet port, which is a surprisingly plentiful amount of connectivity considering the limited physical space. GIGABYTE leaves the storage (an mSATA SSD slot) and memory (two DDR3L SO-DIMM slots) open, so you can customize the kit to suit your needs.

THE PERFECT GIFT FOR: *PEOPLE WANTING A COMPUTER THAT CAN BE EASILY HIDDEN AND/OR FIT INTO TIGHT SPACES—LIKE A STOCKING.*

Cooler Master Xornet II

$34.99 • gaming.coolermaster.com

The ergonomics of a mouse is especially important for those using the claw grip, as the constant arch of your fingers can easily cause fatigue. Cooler Master designed the Xornet II specifically for gamers that use the claw grip. It's shaped in a way that prevents cramping and delivers ideal comfort. Cooler Master starts with a lightweight design that helps to further enhance the claw grip's natural precision and movement advantages. The Xornett II also provides large ring finger and thumb rests (with anti-slip rubber sides) for stability when moving the mouse.

An Avago 3320 optical sensor is onboard for exceptional tracking accuracy. You can switch among three DPI modes (from 500dpi to 1,250dpi to 3,500dpi) on-the-fly via the DPI button. The Xornet II also includes a LOD (lift off distance) button, so you can quickly calibrate the sensor for different surface types. Overall, there are seven programmable buttons on the mouse, including two thumb buttons. The Xornet II's customization is a cherry-on-top for gamers who prize comfort and accuracy above all else.

THE PERFECT GIFT FOR: *GAMERS WHO WANT A MOUSE THAT'S BEEN BUILT SPECIFICALLY FOR THOSE USING THE CLAW GRIP.*

Aerocool VX-700

$69.99 • www.aerocool.us

Entry-level builds certainly don't demand a high-wattage PSU, but it's nice if you have enough juice to accommodate at least one powerful GPU. Aerocool's VX-700 boasts a +12V rail that can handle up to 54A, as well as two PCIe 6+2-pin connectors. At $69.99, the PSU is also priced right for an entry-level unit. Aerocool integrates a variety of electrical protections, so the VX-700 won't let your PC hardware be damaged by power fluctuations. You'll find support for over-power, over-voltage, under-voltage, and short-circuit conditions. In terms of power efficiency, Aerocool rates the PSU for a peak efficiency of 81% at 50% load.

The VX-700's connector options are well thought out. There's a 20+4-pin main power, one 4+4-pin EPS12V (to power the CPU), and two PCIe 6+2-pin connectors. The VX-700 also provides six SATA connectors, three Molex cables, and one floppy connector for I/O devices and fans, among others. If VX-700 seems like more power than you'll need, Aerocool also offers a VX-500 that retails for only $44.99.

THE PERFECT GIFT FOR: *PEOPLE IN NEED OF A RELIABLE PSU THAT HAS ALL THE CONNECTIVITY YOU'LL NEED FOR A MODERN BUILD.*

Thermaltake Core P5

$149.99 • www.thermaltake.com

When reviewing PC hardware, we often mention how stylish a particular component looks, and yet, conventional cases—even those with side-panel windows—hide the attractive hardware inside a dark box where it's to difficult to see detail work. Thermaltake's Core P5 is a case design that embraces the idea of your PC as a work of art. The case is basically a black steel panel sporting a variety of mounts, which are all behind a glass frame. You can hang the Core P5 on the wall, sit it on your desk using the included feet, or lay it flat.

There are plenty of openings in the steel panel (and space behind) to hide your system cables, as well as storage devices. The Core P5 supports dual GPUs and liquid cooling components, including up to 480mm radiators and 140mm case fans. As such, enthusiasts receiving the case won't have to restrain themselves with hardware choices. Did we also mention it only costs $150? That's less than some other high-end cases sporting excellent liquid cooling support—and you can't mount those on a wall.

THE PERFECT GIFT FOR: *BUILDERS WHO WANT A CASE THAT LETS THEM SHOW OFF THEIR PC HARDWARE.*

Aerocool Aero-1000

$99.99 • www.aerocool.us

Earlier this year, we selected the Aero-1000 as the case for our Battle Box build that we gave away at QuakeCon. And having spent quite a bit of time with it, we can confidently say this case is much more than what you'd expect from the $99.99 price tag. For example, Aerocool makes the mid-tower compatible with big, powerful enthusiast components. It has a removable drive bay cage that lets you extend the maximum graphics card length from 11.4 inches to 16.4 inches. The top panel allows for up to 280mm radiators, and Aerocool recesses the panel, so you can install both a radiator and fans without having them hang over the motherboard tray.

The Aero-1000 is the flagship model in Aerocool's PGS-A case lineup, which also includes the Aero-800 ($79.99) and Aero-500 ($69.99) models. The Aero-800 and Aero-500 are slightly smaller and slimmer than the Aero-1000, while still offering support for high-end components. All models feature a clean, elegant exterior, and you can choose between white and black editions. Aerocool does a great job of providing a variety of budget-friendly options.

THE PERFECT GIFT FOR: ***THOSE WHO NEED A MID-TOWER CASE THAT SUPPORTS TODAY'S BIGGEST GRAPHICS CARDS AND LARGE RADIATORS.***

MSI Nightblade MI2-001BUS

$299.99 • us.msi.com

* Video card not included

Assembling a miniature LAN party rig can be challenge. You must provide sufficient cooling, find a compatible motherboard, and still have space for a full-size GPU. With the Nightblade MI2, MSI has already done much of the hard work for you. This barebones kit includes a compact case (9.2-inches tall and 5-inches wide), a motherboard that supports Intel's latest Skylake processors, and a power supply. The Nightblade MI2 boasts MSI's premium Audio Boost technology, as well as GAMING LAN MANAGER with Advanced Stream Detect to classify and prioritize game packets on your network. Support for wireless communications is also onboard, thanks to an Intel Wireless-AC 3165/Bluetooth combo module. There's also a proprietary CPU cooler that maximizes cooling performance in the limited space. To finish the system out, you just need to pick the Skylake processor, GPU, memory, storage, and OS. For the GPU, you can install dual-slot cards up to 290mm in length, so you could, for instance, equip a GeForce GTX 970. For storage, you can install up to one 2.5-inch drive, two 3.5-inch HDDs, and one M.2 PCIe SSD. The Nightblade MI2's two DIMM slots can handle up to 16GB of DDR4 memory.

THE PERFECT GIFT FOR: ***LAN PARTY GOERS WHO WANT TO BUILD A MINIATURE SYSTEM AROUND INTEL'S SKYLAKE PROCESSORS.***

COOLER MASTER
Make It Yours.

"I AM ALL ABOUT CREATING ON THE FLY, CREATING SOMETHING NEW. I AM A MAKER."

Dave 'drdavient' Cooper 2D GAME DEVELOPER

Dave is a man of many hats. Literally. He splits his time between tech entrepreneurship, game designing, guitar playing and songwriting, university educating, and improvised performance. Dave uses a **MasterCase 5** system for his independent 2D game development and playing needs, but which thanks to the **FreeForm™ Modular System** also offers the flexibility to customize, adjust, and upgrade to meet the demands of whatever catches his fancy in the future.

Learn more about his system and Blockships 2D, an arena combat fight fest game that he's been working on at Coolermaster.com/Dave

MasterCase 5 - Make of It What You Will.

ASUS Reinvents The Ideal Gaming Monitor

ROG Swift PG279Q Has Features Galore

If you're a regular *CPU* reader, then you already know, the first thing you do to improve your gaming visuals is get a competent graphics card. But you don't stop there, the monitor you pair with that graphics card is a vital component, and its quality effects everything you do with your PC, especially gaming. The ASUS ROG Swift PG279Q ticks all the boxes when it comes to technologies that deliver impressive visual fidelity, but it also features a multitude of other features that improve the comfort and enjoyment of your overall computing experience and can even give you a competitive edge.

Comfort & Style

This monitor features a matte charcoal black finish with triangular-shaped panels on the base, back of the monitor itself, and the stand. There's a red ring around the monitor's base and a ROG logo that pulse with light (you can turn them off via the OSD, Light In Motion setting). As with many of the gaming-centric ASUS monitors we've looked at, this monitor is fully adjustable, supporting height (120mm total), tilt (-5 degrees and + 20 degrees), swivel (-60 degrees, +60 degrees), and rotate (90 degrees, for portrait or landscape viewing modes) adjustments.

Are you currently running or considering upgrading to a multi-monitor setup? Then you'll be happy to note that the PG279Q has just 6mm of bezel on the right and left edges of the screen, letting those gaps all but disappear when you're gaming or multitasking across your ultra-wide Desktop. In addition to the DisplayPort and HDMI inputs,

ASUS reserves the "ROG Swift" designation for its gamer-focused monitors.

this monitor features a pair of USB 3.0 ports, a USB 3.0 upstream port and the requisite cable, as well as a headphone jack. The frame around the panel has a matte finish, but unlike the rest of the housing, it's black, helping it blend into the background so you can focus on the games and applications at hand.

If you're reading *CPU*, chances are good you spend a lot of time in front of a monitor. To ensure that time remains comfortable and enjoyable no matter how long you use the PG279Q, ASUS added a handful of Eye Care Technologies designed to ease eye strain and combat visual fatigue. Despite the ubiquitous popularity of LED-backlit monitors, some users of the displays can perceive a flickering of the backlight caused by the PWM controller that maintains the light's consistent brightness. This forces your pupils to dilate and contract repeatedly, which can cause eye strain and even induce headaches. With ASUS' Flicker-Free feature, however, this stroboscopic effect is significantly reduced, letting you comfortably use the monitor for extended periods.

Solving the flicker problem can work wonders for most things you do on your PC, but when gaming, reducing the strobe can actually blur the image somewhat. To address this issue, this

The LED base and ROG logo lighting are slick, but not mandatory.

delivers 77% more desktop real estate, so you can view more windows simultaneously, multitask more effectively, and take in more of the sights and sounds. It's still a 16:9 aspect ratio, so you're seeing every inch of the movies, TV shows, and web-based widescreen content you love.

The 3.7-megapixel panel ASUS installed in this unit features an impressive 0.233mm pixel pitch, which means that the pixels are crammed in close, to the tune of 109 pixels per inch. The benefits of such a high pixel density mean everything that appears on this monitor shows up crisp, vivid, and as true-to-life as possible.

Last year, we took a look at the ROG Swift PG278Q, equipped with a high quality TN (twisted nematic) LCD panel that supports refresh rates up to 144Hz. Now, ASUS is back with the PG279Q built around a significantly improved IPS (in-plane switching) panel. As such, the monitor is capable of displaying accurate colors on every square inch of the display, which makes it ideal for gaming. The monitor also supports 178 degree vertical and

monitor supports NVIDIA Ultra Low Motion Blur technology, which strobes the backlight at a high frequency. You can even adjust the pulse width via the OSD to find the right balance. Refresh rates fixed at 85Hz, 100Hz, and 120Hz support this feature.

Light on the blue-end of the spectrum is harsh, and too much blue light coming from your monitor can have a detrimental effect on your vision. To alleviate this common problem, this monitor supports a series of low blue light emissions settings, which give you up to four filtering levels to choose from in the OSD, for up to 70% less blue light. The screen on this monitor also features a matte-finish to reduce glare and distracting reflections, which is yet another way it can promote a comfortable computing experience.

Gamer's Delight

From every angle, the ASUS ROG Swift PG279Q delivers an eye-pleasing experience. This is a 27-inch monitor with a 2,560 x 1,440 WQHD (Wide

Quad High Definition) resolution. For those upgrading from a 1,920 x 1,080-resolution display, the PG279Q

Being able to adjust the screen height is an important way to improve your viewing comfort.

horizontal viewing angles, and it offers vivid color reproduction based on 100% of the sRGB color space. The monitor is a real 8-bit model that supports 16.7 million colors.

Your blacks will be dark and your whites bright thanks to the PG279Q's 1,000:1 contrast ratio and a brightness rating of 350 cd/m2. Together, these specs help deliver vivid realistic images regardless of the application. Furthermore, ASUS Trace Free Technology shrinks the gray-to-gray response time to a mere 4ms (with the "extreme" overdrive setting enabled), which eliminates ghosting in even the most fast-paced scenes and highly competitive FPS and racing games.

It's true, MOBAs are very popular these days, and one of the reasons for

ASUS Trace Free Technology shrinks the gray-to-gray response time to a mere 4ms.

this is due to their limited performance demands. Running League of Legends or DOTA 2 at a 60Hz refresh rate will not affect your ability to crush your opponents. For gamers who play modern racing games and shooters, however, the higher you can push your refresh rates, the more likely you are to succeed. As such the PG279Q supports 60Hz, 120Hz, 144Hz, and 165Hz refresh rates. You can even adjust the refresh rates on-the-fly using the Turbo shortcut button, just above the power button.

We've mentioned it with regard to previous ASUS ROG Swift monitors we've looked at and it's true here as well, the 5-way OSD navigation joystick on the backside of the right-edge make finding the settings you want fast and easy. One of the adjacent buttons manages a feature called GamePlus technology, which can superimpose one of four different crosshairs overlays to help improve your aim. There's also an FPS counter for finding the best settings in your games and, for the speedrunners out there, GamePlus also lets you enable an onscreen timer.

There are six GameVisual display mode presets that come preloaded in the ASUS ROG Swift PG279Q, which optimize the settings for Scenery, Racing, Cinema, RTS/RPG, FPS, and sRGB. You can also adjust the color temperature using Normal, Warm, and Cool presets, or make your own using the Custom setting.

Smooth Operator

Although the higher refresh rates of the PG279Q can draw frames at an incredible pace, no graphics

card is going to be able to match your refresh rate in every game. Traditionally, Vsync is a technology that uses a buffer to store frames until the monitor is ready to draw them on the screen, at set intervals. When the GPU's ability to render frames drops below the refresh rate, however, Vsync

If you have a choice for which input to use, opt for DisplayPort over HDMI.

Tilt is nice, but with such a wide viewing angle, this display looks great from every angle.

can redraw the old frame while it waits for a new one. This results in a perceptible stuttering, and often it comes at the worst times in games, right as all the action is going down. Turn off Vsync and you create a new problem, screen tearing, where the monitor stops in the middle of a screen draw to begin drawing a new frame. Neither is ideal and both have been plaguing games for so long that many gamers have just learned to live with the annoying and distracting phenomenon.

The best way to eliminate these issues is to use a variable refresh rate, whereby the graphics card can dictate how often the screen draws an image. NVIDIA was the first to implement variable refresh rates, as G-Sync, and it's how the ROG Swift PG279Q is able to manage this feat. It truly is a game changer, and as the mere existence of AMD's FreeSync technology proves,

The four OSD buttons and the 5-way joystick on the back of the display make finding the settings you want fast and simple.

Want to view the ROG Swift PG279Q in a portrait view? You can do that.

it's a compelling feature that gamers want. (NVIDIA GeForce GTX 650Ti BOOST or higher required.)

Although this monitor supports both DisplayPort and HDMI, you'll get the most out of it using the former. The peak 2,560 x 1,440 resolution is possible via HDMI, but the interface isn't capable of refresh rates above 60Hz. Furthermore, G-Sync's screen-smoothing wizardry only works via DisplayPort.

During the monitor's initial design and testing phase, ASUS discovered that the heatsink on the G-Sync module was getting rather warm when operating at the 165Hz refresh rate. Don't worry though, ASUS' engineers solved that issue by moving the power supply to an external box and adding a striking vent design you'll notice on the back panel of this display. The Smart Air Venting Design uses the natural force of convection to passively draw heat away from the components producing it (read: no noisy fans). These factors ensure the PG279Q

keeps heat in check, even during those marathon gaming sessions.

There's also a set of built-in 2-watt stereo speakers, which eliminate the need for standalone speakers. Hidden behind four rubber tabs on the back of the monitor are screws that let you remove the stand and install the panel onto any VESA-compatible stand or mount.

Serious About Entertainment

The ASUS ROG Swift PG279Q is a monitor that has a lot to offer: superior refresh rates up to 165Hz, NVIDIA's variable refresh rate G-Sync technology, and impressive visuals that only a high quality IPS panel like this could deliver. Comfort and eye strain-easing tech is also there to keep you enjoying this monitor long into your late night raids and during those 24-hour LAN parties. If you're ready to get serious about your gaming, isn't it about time you got a monitor that's on the same page? ■

Specs: 27-inch (2,560 x 1,440); 16:9 Aspect Ratio; Pixel Pitch: 0.233mm/109 PPI; Brightness: 350cd/m²; 16.7 million colors; 4ms Response Time (GTG w/ extreme overdrive setting); 6mm bezel; tilt, swivel, pivot, and height-adjustable stand; Ports: DisplayPort 1.2, HDMI 1.4, 2x USB 3.0, 3.5mm jack audio; 2x 2-watt stereo speakers

Caged Heart

I t's easy to see at a glance why Ben "Bennyboy1337" Lzicar named this month's Mad Reader Mod "Caged Heart." What's less obvious is how he came across the idea in the first place.

"I typically like to make mods that nobody has thought of before, or ever done, like the Kegputer I built for NVIDIA a few years ago," Lzicar says. "This time, I got inspiration from a video I saw of a pulsating tumor in a computer by a Japanese artist named Mio Lizawa. I thought, 'Man, why hasn't anyone done anything like this for a liquid-cooled PC yet?' then off I went researching how to make silicone casts and designing a pulsating heart."

Doing His Cardio

Lzicar built Caged Heart from the ground up. He says the case took him about a month once he designed it in SketchUp. It took a couple weeks to cut and weld the frame, and Lzicar says that powder coating the steel, doing the woodwork, and building in the components and completing the wiring took a couple more.

The centerpiece of this mod, though, is of course its animatronic heart, and Lzicar says building that took three times as long as the rest of the system.

"Making an inflatable silicone heart was the most time-consuming part of the whole project," he says. "You have to remember, I had zero experience with making casts of any kind, let alone the fact that relatively nobody has ever done anything like this before. The one person who has (Lizawa) left no worklog.

"Sculpting the heart was fairly straightforward using Monster Clay, a reusable oil and wax sculpting clay. I looked up a 3D render of a heart and tried to copy it to a realistic size. After the sculpture was done, I had to figure out how to make a good mold; I went with silicone since it is a sturdy and flexible medium. When cutting open the mold and trying to remove the heart, I found that small sections between valves would often rip apart, so I had to redesign the heart sculpture several times to make it more cast-friendly. Each time it cost me about $30 of silicone, and lots of time."

And that was only the beginning!

"Once I got a reliable mold, I had to make a good cast of the heart, however the heart had to be hollow and able to withstand being inflated and deflated constantly," Lzicar says. "Creating a good cast proved just as hard as making the mold. I decided to go with the same two-part silicone for the cast, which meant I had to use a release agent so the two parts wouldn't stick together. I had a hole cut at the top of the mold to pour silicone in, then plugged the hole and proceeded to roll the mold around for about 30 minutes while it cured. I went through about 18 different casts until I got one that was suitable. All told, it took me about three months of on and off work to make the heart."

Lzicar used a mixture of silicone caulk and enamel paint to give the heart its deep red color. Using standard paints wasn't really an option because it was difficult to make them stick to the silicone heart in the first place, and Lzicar wanted to ensure that the color wouldn't flake or crack as the heart expanded and contracted. "If I had known how ridiculously hard it would be to paint silicone, I would have invested in some silicone dye prior to making the cast, and painted the heart before it cured," he says.

It's Alive

Once the heart was complete, Lzicar had to find a way to make it beat. He settled on a pretty cool combination of tech parts to make it so. He rigged a 12-volt vacuum pump to draw the air from the heart, causing it to contract, and left a tiny hole in the air tube that allows the heart to inflate again when the pump shuts off during each beat cycle. He controls the whole thing with an Arduino unit with custom Python code that he wrote that links the speed of the "heartbeat" to the system's CPU usage.

"The rigid acrylic tubing of the cooling loop runs through the heart, but no liquid runs freely in the heart," Lzicar says. "The lines are simply there to create the illusion that it is full of coolant, and that the heart pumps the liquid."

Cool beating hearts aside, Caged Heart consists of an Intel Core i5-4690K on an MSI Z87I AC Mini-ITX motherboard, 8GB of Crucial Ballistix Tactical Tracer memory, a ZOTAC GeForce GTX 970, a SilverStone SFX Series 450W power supply, and two 1TB Crucial MX200 SSDs in RAID 0. The cooling loop comprises Cooler Master JetFlo 120 fans, an EK Supremacy EVO CPU block, an EK-FC970 GTX VGA block, an EK CoolStream PE 240 dual rad, an EK DCP 2.2 X-Res pump and reservoir combo, an EK RES X3 110 reservoir, and Monsoon Hardline tubing.

PDXLAN

We first saw Lzicar's work at PDXLAN, where he is a frequent attendee. He says that for anyone who is interested in learning more about the modding world, attending PDX is a great way to get started.
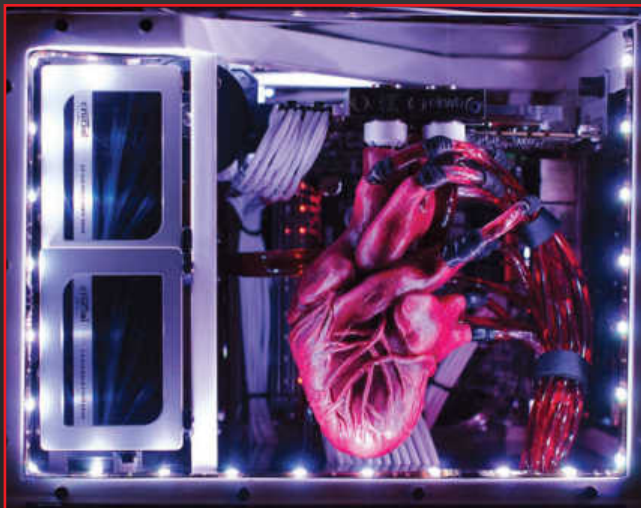
"I have made some lifetime friends at PDX, and probably wouldn't have my amazing job working at Crucial Memory if it wasn't for the acquaintances and opportunities that attending the LAN has given me."

He says he's working on a custom torture rack build for a friend to take to the next PDXLAN in February, but after that he intends to revisit his Kegputer build, "with a more practical twist involved." We'll see you there, Ben, and we'll be sure to bring a Solo cup or two. ■

Another Year Of LAN Parties Is In The Books

In October and November, the last three LAN parties of the 2015 LANFest season burned brightly and went out, ending the year with a bang. The next LANFest event will be LANFest MLP'016 Winter, on January 8 at the Erie County Fairgrounds in Hamburg, New York, and will kick off yet another year of amazing LANs.

LANFest NETWAR 29.0

We love NETWAR because it's about a 45-minute drive from *CPU* HQ (Google Maps says 48) in Elkhorn, Neb., which is part of the Omaha metro. We also love it because it's awesome; the LANFest crew headed up by Travis Kreikemeier and Craig Schmaderer know how to put on a LAN, and although the event has changed venues several times in the last five years or so, it's always unmistakably NETWAR. The latest event, held at The Mark on October 9 and 10, included Team Fortress 2, Rocket League, League of Legends, and Heroes of the Storm tournaments, as well as several free-play events, an enormous prize raffle, and more.

We saw a bunch of cool systems and mods at NETWAR as usual. The winner of the *CPU* Mod Contest was Dillon Grossman, whose Phanteks Enthoo Primo was packed with heavy-duty hardware, including custom-sleeved cables and a full-system SLI watercooling loop.

LANFest Austin Fall 2015

On November 13 at 7 p.m., LANFest Austin kicked off at Intel's Austin offices on the MoPac Expressway. The event ran through 2 p.m. on Sunday, November 15, and included tourneys in League of Legends, Rocket League, Team Fortress 2, DOTA 2, and Unreal Tournament 2004.

Several attendees entered their mods in the *CPU* Mod Contest, but of course we could only pick one winner, and that turned out to be Hassan Alaw, who incidentally took third place in the Bethesda/id category at QuakeCon 2014 with his Fallout Eyebot mod. His gorgeous QuakeCon-themed mod is immaculate inside and out.

LANFest Great Escape LAN V Fall 2015

The 101-person LANFest Great Escape took place at Great Escape Games in Sacramento the same weekend as LANFest Austin, and consisted of 47 hours' worth of tournaments, a gingerbread construction contest, and more. All proceeds from the event went to the Make-A-Wish Foundation of Northeastern California and Northern Nevada.

Randall Philippi won the CPU Mod Contest with his ammo can mod, based on a Corsair Vengeance C70 (naturally). Philippi originally built the mod for a friend of his who's part of a tank crew in the Army, but we're glad he went to the effort of bringing it to the LAN! The mod includes various odds and ends associated with Army life, and Philippi also added some camo netting and diamond plate to complete the look.

Q&A With Brian Carter
Boddaker On All Things Mod

Q: Hey Brian! Last month, Bill Owen said he got into modding PCs by way of modding cars. You have a similar background, correct? Tell us about the Javelin, and talk about how you got your start in PC modding.

BC: Yes, I'm a hot-rodder as well, and have been tinkering with muscle cars since high school, when I bought my first car with the help of my Dad. It was a 1971 AMC Javelin SST. I am only the second owner, and I took my driving test in it. I've rebuilt it several times since then, and it's been in numerous car shows throughout the years. I managed to take home a few trophies with it, but I never really considered it finished, as I was always working on it. And it still exists in my garage to this day, awaiting the next rebuild.

My case-modding hobby came much later, and believe it or not it began with paintball. My car buddies and I started playing paintball just after high school, and it lasted up until we realized we could get the same kind of fix by playing first-person shooters on the PC. We were doing our own mini-LAN parties at home, playing games like Duke Nukem, Blood, and Shadow Warrior. It was around the time of Unreal Tournament and Half-Life that I started hot-rodding my PC. I was the first of the bunch to put a window kit and blue lighting effects in my case. My first official case mod was the Sideview PC where I integrated my 19-inch flat-screen into the side of the case so I could transport my rig easier and save some desktop space at our LAN parties. I was hooked from then on, modding cases for my mom and dad, and other family members.

Q: What is it about modding in general that most appeals to you?

BC: Coming from cars, I really like working with the smaller size of PC cases where projects would take only a few

Brian Carter (actual size) and his amazing Cosmos Cruizer mod.

months, as opposed to years. I did, however, revert back to that time frame for my recent Cosmos Cruizer case, but since it was a hot-rod-themed build, it was not surprising that it took two and a half years!

Q: When did you start Bods Mods (www. bods-mods.com), and what prompted you to turn your hobby into a business?

BC: I started Bods Mods more to show-case my builds than to promote a business. Case modding is still just a hobby

for me, as I could never really make the leap of faith to do it full time. I still welcome the occasional commission build, though, and I love working with companies, creating mods for events like CES and COMPUTEX.

Q: Which is more challenging: The idea and design phase, or doing the actual work to make the design come to life?

BC: I come up with amazing ideas all the time. It's making those grandiose ideas come to fruition that can

be the challenging part. Some were just not meant to make it outside my head!

Q: Which of your mods would you say are your three favorites, and why?

BC: My favorite mod so far has got to be the Cosmos Cruizer. It came out even better than I could have imagined, thanks to the amazing paint job Bob Stewart of BS Mods did for me. Words cannot express my gratitude for all he's done to help me finally get that thing finished.

I also loved building the TRON Lightcycle PC, which was a full-on scratch build. It got a ton of exposure and created quite a stir with the curved radiator I had custom-built specifically for it. (Special thanks to PrimoChill for all the help!)

Lastly, I think Neptune's Trident rounds out my top three. Again, it featured innovative things not too many people were doing at the time, like water channels in the floor, and custom paint simulating water droplets.

Q: Back in 2009 when your Battlestar Galactica mod was on our cover, you told us that you spent 500 to 700 hours on it. So, say it was 600 hours—that's like working a full-time job for 15 weeks. That is pretty crazy! Is that the longest you've spent on a mod, and if not, what is?

BC: Creating the detailed armor exterior for BSG was very time consuming, as well as fabricating the top landing bay and engine pods from scratch. All those hours were spread out over a year and a half, so it didn't seem like a whole lot until you added it up. I even took a few months' break when my daughter was born. But that still doesn't compare to the Cosmos Cruizer, which took more than two years to complete. I don't even want to try to figure out how many hours that took!

Q: We've all noticed over the years that as certain design aspects become trends among many modders, case

The TRON Lightcycle PC, December 2011's Mad Reader Mod.

manufacturers and other component makers will eventually incorporate some of those things into their designs. What's your favorite case design update, and why?

BC: I'm starting to see more and more case designs embracing the PCI extender cable, or riser cards, to reposition the graphics card so it lies parallel to the motherboard. This makes more efficient use of the space and makes the top of the card more visible. And depending on how long the extender cable is, the graphics card could even be relocated to another part of the case.

Q: It's time for Five Quick Questions!

Neptune's Trident, Dec. 2009's Mad Reader Mod.

1) Chevy or Ford?

I'll have to add a third option here and say AMC. I tend to want things that not everybody has. Don't get me wrong, I love to see Camaros and Mustangs done well, but how often do you see an old Hudson or AMX driving down the street? Those are the things that really turn people's heads and make them ask, "What the hell is that thing?"

2) Intel or AMD?

I started out with AMD, mainly due to being on a college budget, and Athlons were a lot cheaper than Pentiums back then and had decent performance. Now I'm pretty much all Intel.

3) Batman or Superman?

Hmm, I would say Batman because he has more cool stuff and built his own gadgets, whereas Superman just has a big S and was basically born with everything. There have been more Batman-themed case mods than Superman mods for a reason!

4) World of Warcraft or Call of Duty?

I never got into RPGs, so WoW wasn't that appealing to me. But give me a good first-person shooter any day!

5) Starbucks or Folgers?

I never liked coffee until someone put chocolate into it. Give me a Starbucks mocha and I'm ready to mod all day and night!

Q: OK, final question: Can we have your Battlestar Galactica mod? (Hint: The correct answer is "Yes.")

BC: I'd gladly let you have it, but it sold five years ago to a BSG fan in L.A. But I might be tempted to build another one . . . maybe a Mini-ITX version. [Smiles.] ∎

OC Suite Shootout

Graphics cards, motherboards, and processors are the heart, soul, and lifeblood of the PC. We cover a lot of them here in *CPU*, but we don't often get to talk much about the software utilities designed to tweak and overclock those components. Now we're rectifying that travesty with this rundown of the utilities from ASUS, SAPPHIRE, GIGABYTE, MSI, EVGA, AMD, and Intel.

The BIOS Isn't Always Your Best Option

Most of the record-breaking overclocks you see come about as a result of tweaking the motherboard BIOS. Because this small embedded chunk of code dictates the CPU core and memory clocks, memory latencies, voltages, temperature thresholds, fan speeds, and bus bandwidths, where applicable, you can expect that any changes you make in the BIOS will remain constant regardless of any changes that occur to memory-resident code. This benefit is also the Achilles' heel of BIOS-based overclocking.

The primary drawback to BIOS overclocking is that your system's built-in protections, such as the temperature thresholds it uses to ensure your components don't burn out, may not register something as detrimental as a stratospheric voltage setting until the processor has had a chance to run at the setting, however briefly. If your cooling setup, voltage regulators, traces on the motherboard, or any of the countless other factors involved in overclocking can't handle the power you're trying to force them to operate under, there's a real

AMD's Catalyst Control Center does its job well, but there's something new from AMD on the horizon.

possibility that one or more will buckle. Avid overclockers always have a story or two about that component that went up in a shower of sparks and cloud of smoke. More often, however, the damages are less obvious, leading inexperienced overclockers to continually reboot using the damaging settings, further compounding the problem. This can even lead to multiple failed components. Similar mistakes can occur with software-based overclocking, but the chances are significantly reduced.

The startup process is particularly demanding on your system even at stock settings. When running at increased voltages and redlined clock speeds, the startup sequence is like slamming your foot on the accelerator while also holding the brakes. And when walking the line

between a stable overclock and a frowny-face blue screen, the stress of startup may be your only limiting factor.

Soft Tweaks

When you make your adjustments using a Windows-based utility, the system boots with the settings at their default values, and only after the startup process has completed does the software overclock your components. Many utilities can also display real-time cooling and performance numbers for multiple components. Using overclocking software also lets you create two or more overclocking profiles and use hotkeys to enable/disable them when appropriate. For instance, there's no reason you should be running a higher graphics core and memory clock when you're working on a Microsoft Office document or browsing the Web. When you're about to launch a game, however, just hit the hotkey that corresponds to your tweaked graphics settings, then launch the game and enjoy improved frame rates.

Software-based overclocking does have its drawbacks, of course. Some applications, usually motherboard-based utilities with some form of automatic overclocking functionality, are brand- or hardware-specific and may not work with components from another vendor. Furthermore, the ease of navigating the UI and finding the setting you are looking for can vary wildly. It is with these concerns in mind that we set out to determine the current state of software overclocking. Let's get tweaking.
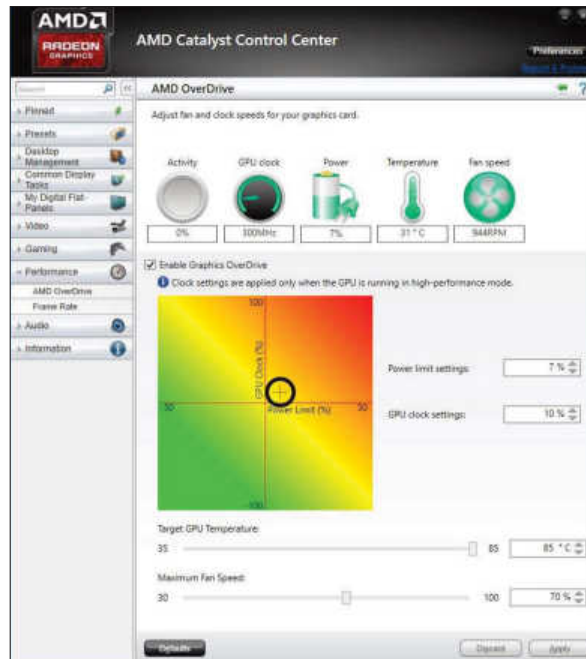
When you decide to overclock your AMD gear, turn to OverDrive.

AMD Catalyst Control Center

As we went to press, the latest version of AMD Catalyst Control Center was 15.7.1, the ominously-dubbed "Omega" driver. This is the software component that lets you tap in to both AMD-based APUs and GPUs. In addition to letting you tweak your hardware settings, CCC also offers a nifty overclocking suite called OverDrive.

User interface. The interface layout (in the more useful Advanced View) features a column on the left that lists the main functions, including Presets, Desktop Management, Common Display Tasks, My Digital Flat Panels, Video, Gaming, Performance, Audio, and Information. Click any category to access a series of functions. For instance, the Desktop Management item expands to let you view Creating And Arranging Desktops, Desktop Properties, Advanced Display Settings, and Desktop Color. Click any of these functions, then click the pushpin icon at the top of the screen to add it to the Pinned category in the top of the left column. This is a good feature considering the fact that there are a ton of tweakable settings, but only a handful you'll use regularly.

The Performance category provides access to the utility's overclocking functions.

When overclocking your AMD-based graphics card, click the Enable Graphics OverDrive checkbox and click Apply to get to tweaking. Keep in mind that if you have an AMD-based Black Edition processor, you'll get access to a host of other overclocking options, including CPU Power, CPU OverDrive, and AMD OverDrive.

The Frame Rate item in the Performance menu lets you manually set your frame rate target to conserve power, reduce fan noise, and slash the system's overall heat output. Just click the checkbox and move the slider to your desired fps limit and click Apply. If you're a gamer looking for the best visuals, there's another reason to give this feature a whirl: by setting the fps limit to your monitor's refresh rate (60fps for a 60Hz monitor), you can virtually eliminate screen tearing.

Limitations. Rather than showing you the default core clock, the AMD OverDrive portion of CCC displays the current GPU clock, which, depending on your graphics card, may display anything from the stock (or factory overclocked) core clock to an idle mode clock that hovers at about 300MHz. If you're running a GCN 1.1 (Graphics Core Next) or newer graphics card, you can adjust two parameters, GPU Clock and Power Limit Settings, and you'll do so in percentage increments, rather than by adding megahertz to the default clock. On one hand this helps make sure you don't bite off more than you can chew when overclocking, but it makes determining your final core clock a bit of a chore for the math-averse. (*NOTE: When you click the Information item from the left column and then click Hardware, the clocks reported here don't reflect your overclocks; you'll need to use*

CPU-Z [www.cpuid.com] or GPU-Z [www.techpowerup.com] to determine real-time core clocks.) Those with GCN 1.0 or earlier cards will be able to adjust the core clock in megahertz.

Sadly, the benchmarking capabilities have been stripped from the Catalyst Control Center, as has the AutoClock menu, which used to let the software slowly raise the processor's values to find a stable overclock. There are no monitoring and logging functions, and serious overclockers will balk at the lack of voltage controls.

Although it's looking rather long in the tooth, the Catalyst Control Center delivers the basics for viewing stats about and overclocking your AMD-based hardware. But by the time you read this, AMD will likely have launched its new driver and hardware-tweaking suite, called simply Radeon Software, which will replace the Catalyst Control Center.

According to Terry Makedon, senior manager of software strategy at AMD,

Radeon Software, which should be available by the time you read this, is the new face of AMD's settings-tweaking application.

the new software will feature stability improvements, new features, and enhanced performance. The tweakable portion of Radeon Software, called Radeon Settings, is designed to load quickly and be easy to find and use. Based on early screenshots, it looks like you'll even be able to create application-specific overclocking profiles. You can expect other features such as a more intuitive UI; a new game manager; revamped OverDrive; and new Video, Display, and AMD Eyefinity settings.

Intel Extreme Tuning Utility

Intel's processor-specific overclocking suite is called the Extreme Tuning Utility, or XTU. As we went to press, the latest version available was 6.0.2.8, a number that appears to correspond with the current generation of Intel processors, though there's no reason those running older processors can't use the utility. Visit http://intel.ly/1uaRnEQ and click the link to download the latest version. Intel XTU lets you monitor temperatures, frequencies, and CPU utilization; adjust frequency thresholds, voltages, and ratios (multipliers); and even run benchmarks to see if your new settings are effective.

User interface. XTU is laid out like a multipane window, with white text, blue icons and sliders, and a black background. The leftmost pane displays an outline of the application's main capabilities, including System Information, Basic Tuning, Advanced Tuning, Stress Test, Benchmarking, Profiles, and App-Profile Pairing. The System Information screen displays raw specs of various components such as the processor, graphics card, OS, memory, BIOS, motherboard, and the XTU utility itself.

Click the Basic Tuning option to get access to a barebones three-step tuning procedure. It starts with a benchmark, then you can adjust the multiplier slider, apply the settings, and benchmark again to determine if your settings are stable. Our first attempt (4.8GHz) was a bit too ambitious, and the system rebooted. When we launched XTU after the system was up and running again, we got a warning
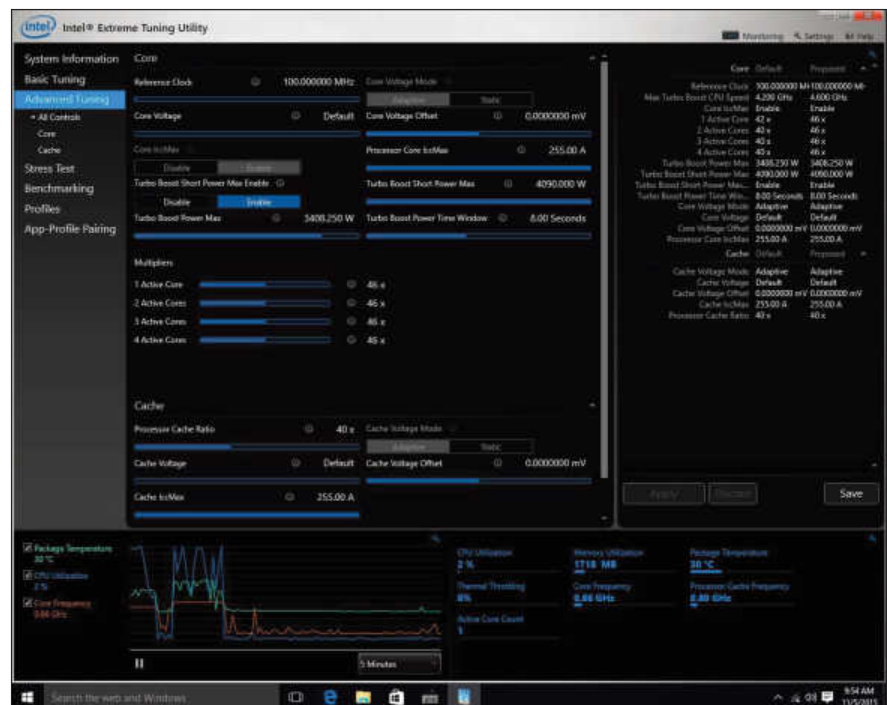
The Intel Extreme Tuning Utility offers plenty of sliders and tweakable settings, as long as your hardware is unlocked.

telling us that the system had restarted unexpectedly. After pushing our Core i7-6700K to a more reasonable 4.6GHz (multiplier set to 46), the benchmark completed and showed us a 70-point improvement compared to the stock settings score. With the Processor Cache Ratio set to a matching 46, our score improved another 10 points. But this just scratches the surface of what the XTU can do.

Click Advanced Tuning from the left pane to expose all the knobs and dials you can adjust. The settings you encounter will be processor-specific, but with our 6700K, we were able to tweak the Reference Clock, Core Voltage, Core Voltage Offset, Processor Core IccMax, Turbo Boost Short Power Max, Turbo Boost Power Time Window, and the multipliers for each active core.

If you're running a discrete graphics card like we are, the on-processor graphics settings won't appear here. If not, then you'll have access to settings such as Processor Graphics Ratio Limit (Multiplier), Processor Graphics Voltage, and Processor Graphics Voltage Offset.

One of the best features of the XTU is that any setting you adjust from the default shows up as yellow, so you always know what's not running at default settings. You can also click the information icons adjacent to each setting to get a more detailed description of what it's likely to do to your system. The Monitoring Panel at the bottom of the screen displays a scrolling graph of the CPU core temperature, CPU utilization, and processor frequency. Click the Monitoring Panel option from the top right of the screen to minimize the settings and just view the graphs and readings.

The Stress Test and Benchmarking portions of the software let you test your settings for stability using CPU-, graphics-, and memory-intensive workloads. Use the Profiles to save the tweaks you want to reuse. The system monitoring pane at the bottom of the window displays a number of useful stats in real-time. Keep an eye on the Thermal Throttling percentage. If you notice any activity on this graph while benchmarking, then you may be

shooting yourself in the foot with your current settings.

We love how modular Intel's XTU is, and clicking the wrench icon in the corner of any pane lets you add or subtract various settings, change the colors of the lines in the performance monitoring graphs, alter temperature units, and adjust font sizes. Another nice bonus is XTU's integration with HWBOT.org, which lets you share and compare your scores with those of others running similar setups.

Limitations. Intel's XTU works best if you have a K Series processor with an unlocked multiplier and are using it on a Z or X Series motherboard. Intel recently cracked down on overclocking with H Series chipsets (even when running K Series processors), so having the right hardware will fully unlock XTU's functionality. Anything less will leave you with greyed-out sliders and missing options, rendering XTU an elaborate system monitoring suite. Another gripe we have with this utility is in regard to the Core Voltage setting. When it's left unchanged, its value reads as Default, which, unless you find out what the stock Vcore setting is for your particular processor, makes it difficult to know how much is too much or too little.

For the most part, these are minor issues. If you have an overclockable Intel processor

ASUS GPU Tweak is powerful and highly informative, but with a simple design.

and the right chipset, the XTU can be a powerful way to push them to the limit.

The Best Of The Rest

Sometimes you can get more bang from your components when running third-party utilities released by AiB (add-in-board) manufacturers such as ASUS, MSI, SAPPHIRE, GIGABYTE, and EVGA. We take a closer look at what they have to offer.

ASUS GPU Tweak

There are a few alternatives for AMD users looking to eke some extra performance out of their graphics cards, but ASUS' option is one of the best.

User interface. One thing we like about GPU Tweak is the fact that it doesn't overwhelm you with sliders, numbers, and endlessly scrolling graphs. The main display shows the GPU Clock, Memory Clock (for the GPU), and the fan speed percentage, with manual and auto mode buttons. Jump into the settings, click the

Tune tab, click the Power Target checkbox, and then click Apply to add this slider to the main interface. You can also add this by clicking the Advanced Mode button in the lower left of the utility. To view real-time temperatures, usage, GPU voltage, GPU fan duty percentage, fan speed, GPU clock, memory clock, memory usage, and power target status, click the Monitor icon in the bottom left. Click GPU Info from the large icons to the left of the sliders to launch GPU-Z, which displays all the specifications for your GPU, including manufacturing node, BIOS version, memory bandwidth, and clocks that are real-time accurate.

There is also a quartet of profile buttons at the bottom of the main panel that let you save and easily switch between your own overclocking settings, and you can access the Hotkeys settings from the Settings menu to make switching even easier. An *S* button loads a preconfigured Silent mode, and a *G* button loads a modest overclock.

EVGA PrecisionX 16

As you might expect, EVGA's utility is specifically designed for NVIDIA-based graphics cards. That being said, it's also one of the better options you'll find from an AiB.

User interface. The UI is designed around a circle that looks like a speedometer. PrecisionX 16 (version 5.3.10) displays the GPU clock, fan speeds, and temperatures all in real-time.

XTU's integration with HWBOT makes chasing records easier than ever.

EVGA PrecisionX 16 is a mouthful to say, but it has all the bells and whistles to push your NVIDIA hardware to the limits.

Below this is a series of sliders for adjusting your power target, GPU temperature target, and the GPU and memory clock offsets. If sliders aren't your thing, you can click each setting and simply type in a number. There's a voltage control setting on the right of the UI and a fan speed setting on the left.

Click the yellow arrow in the lower half of the circle to open a compact series of real-time graphs, or you can double-click this area to expand the graphs into their own window. One more tap of the yellow arrow brings you to the settings menu, which lets you tweak the OSD, fans, profiles (there are dedicated buttons for storing up to 10 of them), and a variety of other aspects of the software.

In the lower left of the pane, you'll find buttons to turn off the OSD, launch the utility at startup, and more. If you have the hardware to support it, this app can really help you push your performance to new heights.

GIGABYTE OC Guru II

GIGABYTE's utility works on AMD and NVIDIA-based graphics cards, regardless of the manufacturer.

User interface. The first thing you'll notice about OC Guru II is that it looks nothing like the overclocking utilities from other vendors. Circular dials are replaced with a modular tile-like interface, with each setting in its own module. Monitoring, GPU Clock, and Memory Clock are the top three tiles, followed by Fan, Minimum Voltage, and Memory Voltage in the middle. The bottom row features OSD, Online Support, and the bottom right is merely GIGABYTE's eye logo. Click the More button in the Monitoring tile to open a larger series of real-time monitoring graphs.

Across the top is a menu bar with five programmable profile buttons, Apply and Cancel buttons, a Default button, and a lock icon, which lets you grey out the settings when you're happy with them. If you have more than one GPU installed, you can also select the GPU you

want to tweak from this top bar. We like the look of this utility, and it's a decent bare-bones option for those looking to make the most of their GIGABYTE hardware.

MSI Afterburner

MSI's graphics tweaking utility gets a lot of its functionality thanks to a licensing deal with RivaTuner. Like the ASUS utility, MSI Afterburner works with both NVIDIA and AMD-based graphics cards.

User interface. MSI's app is built around a large circular dial split down the middle with numbers lining the outside edges. The dial on the left displays the real-time GPU clock up top and the memory clock below. The dial on the right displays the voltage on the top half and the temperature on the bottom half. The settings you can change are arranged in the center of the UI, and sliders let you adjust power limit percentages (for GCN 1.1 and later GPUs), core clock, and memory clock. There will be sliders that are greyed out if not supported by your graphics card, but you can add ones not loaded by default from the Settings menu, including a voltage control. MSI also

The UI on GIGABYTE's app is a breath of fresh air, and it's a competent way to push the needle.

gives users five slots for saving different overclocking profiles.

What we like most about MSI's utility is that, although the UI is a bit muddled, hovering your mouse pointer over any setting brings up a detailed explanation of what the setting does. This pop-up also offers a handful of useful hints to help you understand how the setting can be used to improve performance. For instance, the Power Limit percentage hints helpfully suggest that any settings applied to one GPU are carried over to the rest of the GPUs in your system, for those running a CrossFire or SLI configuration. The hints also say that you can type a number to set the power limit without using the slider, and that you can disable the tooltips from the settings menu.

MSI Afterburner also features a long list of real-time graphs you can use to get a better idea of how your graphics card is performing under your tweaked settings. Click Detach, and you can make the graphs as large or small as you want.

SAPPHIRE TriXX

This utility is similar to ASUS GPU Tweak, but it offers a few unique features that make it worthwhile.

User interface. SAPPHIRE opted for an automobile dashboard-inspired UI, with GPU clock, GPU voltage, and memory clock settings displayed as dials; sliders along the bottom of each
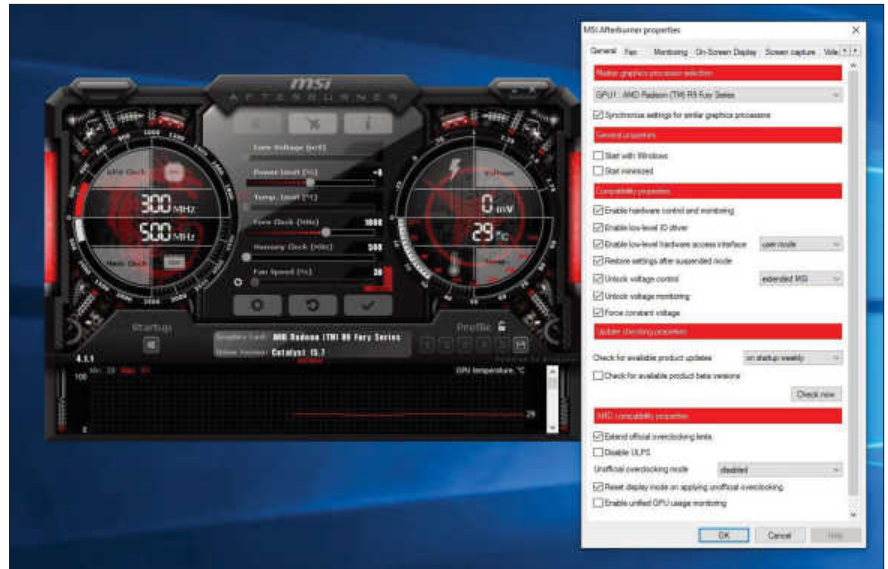
We love how much information MSI manages to pack into Afterburner. And you can turn off those tooltips once you learn the ins and outs.

let you adjust the settings to try your hand at overclocking. GPU and VRM temperatures are readily visible, which gives you a good way to determine how much stress you're putting on your graphics card. There's a Fan control panel that lets you select Automatic, Fixed, or Custom, the latter lets you create your own fan curve to increase the fan duty cycle as temperatures increase.

The Hardware Info button at the bottom of the page displays some basics about the GPU, including the codename, number of shaders/ROPs/TMUs, memory bus, BIOS version, and clocks. You can back up a copy of the BIOS or generate a report using the respective buttons at the bottom of this panel. The Hardware Monitor panel launches when you click the button at the bottom of the main panel, and it shows real-time graphs for core clock, memory clock, temperatures, fan speed in percentages and RPMs, GPU load, and dedicated and dynamic memory usage.

You can create four profiles using the numbered buttons on the right side of the UI. One of the things we really like about this utility is the Log Now button, which lets you record core clocks, memory clocks, temperatures, fan speeds, GPU load, and more. For those looking to pinpoint the perfect overclock, logs like these are a real boon.

Powerful & Precise

It hasn't always been the case, but today's enthusiasts are lucky to have such capable overclocking, testing, and monitoring software utilities from AMD, Intel, and third-party add-in-board manufacturers. If you have yet to see what your processor and/or graphics hardware is really capable of, what are you waiting for? ■

SAPPHIRE TriXX is one of the most useful utilities out there for those with AMD hardware.

The Camper's Code

Coding Bootcamps Promise A Bright, High-Paying Future

Ruby on Rails, JavaScript, Python, PHP, Java, Android, and iOS. If you're fluent in these languages, congratulations, you're in extremely high demand among employers, and not just by tech outfits. Companies in pretty much every industry are increasingly pushing digital initiatives that necessitate hiring developers with coding skills. From 2012 to 2022, the Bureau of Labor Statistics projects an increase of 222,600 software developer jobs (a 22% gain) and 28,500 Web developer jobs (a 20% gain).

Companies are showing they're willing to compensate well to obtain those with coding abilities. Why? Primarily because there's a shortage of people who can code. Experts suggest even computer science graduates from four-year universities aren't well-versed in the latest programming languages companies are using. So where are companies finding qualified coders? Increasingly the answer is coding bootcamps, dubbed "trade schools for the digital age."

Such bootcamps promise to transform campers into desirable job candidates in far less time and at far less cost than attending a four-year university that can easily cost tens of thousands of dollars. Research from bootcamp review site Course Report (www.coursereport.com) puts average tuition for a full-time bootcamp at $11,063 and average bootcamp duration at 10.8 weeks. SwitchUp (www.switchup.org), another review site, puts average tuition at about $10,000 and average length at 10 weeks.

Thousands are signing up, including "career changers" unsatisfied with their current jobs and/or salaries. Market-related statistics and estimates suggest both campers and employers view bootcamps as an extremely viable option. SwitchUp, which describes market growth as "stunning," states there are 200-plus bootcamps globally with nearly 15,000 graduates projected this year.
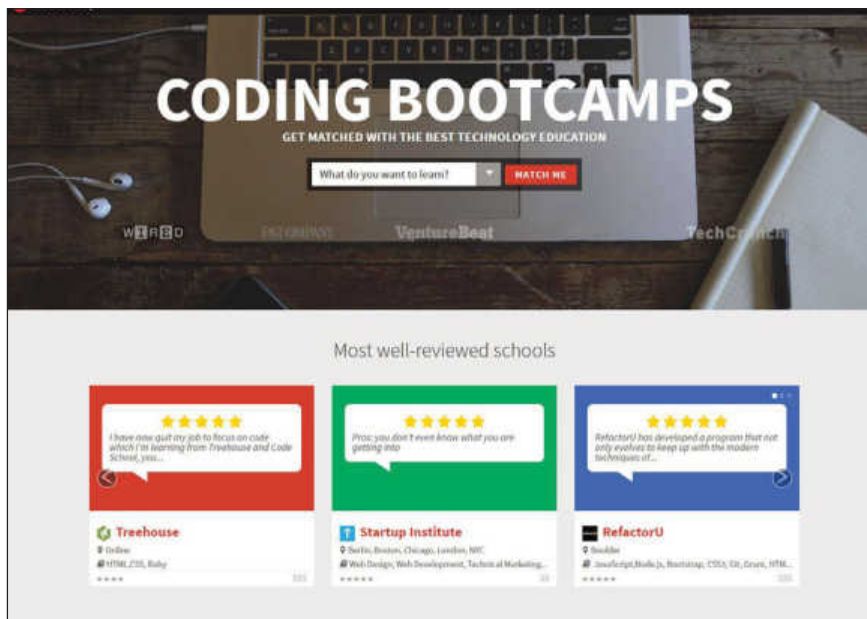
For those considering attending a coding bootcamp, review sites such as SwitchUp provide ample resources to pore over, including ratings, advice for calculating costs, and tools to help select a bootcamp to attend.

Course Report estimates about 60 full-time U.S. bootcamps and camps in 50-plus U.S. and Canadian cities. Course Report projects market growth of 2.4x in the past year, with revenue from tuition for U.S. bootcamps estimated to hit $172 million, up from $52 million last year. Graduates are projected to climb 138% from 6,740 to 16,056.

Jonathan Lau, SwitchUp founder and CEO, says several online or in-person bootcamps are seemingly popping up weekly. And they're proving worthwhile. "The majority of coding bootcamp graduates are getting salary increases and jobs in the tech industry," he says. "From a review perspective, 86% of students report satisfaction with their bootcamp experience. So the whole industry is well-reviewed." Dmitri Ivanov, founder of review site Bootcamps.in (www.bootcamps.in), says

even those who attended universities are interested in bootcamps because "academic education is good, but it won't pay the bills fresh out of school."

Rise & Shine

As the story goes, the seeds for coding bootcamps were planted in about 2011 in San Francisco when Shereef Bishay expressed interest online in running an intense 10-week training camp concentrated on programming. Hundreds applied, and Dev Bootcamp (www.devbootcamp.com) was launched soon after. In New York City, General Assembly (www.generalassemb.ly) began offering classes and workshops at about the same time. Today, it has 14 campuses globally.

Of course, coding bootcamps aren't the only path for learning to code. Free and paid

General Assembly has learning campuses in 14 cities globally, offering full- and part-time and online and in-person courses, including in Web, Android, and iOS development and front-end Web and back-end Web development.

online courses and communities, videos, books, and universities are common avenues. What bootcamps promise, however, is an unaccredited, trade school-like approach that's immersive and intense but that leads to especially high job placement and salaries. Graduates don't earn degrees but instead gain skills and compile portfolios they can parlay into jobs fairly quickly. Depending on the bootcamp, learning occurs through instructors, mentors, former/current developers, and graduates in online or in-person environments.

"Students attend a coding bootcamp to learn a new skill but more importantly to enter a new profession," says Clint Schmidt, COO of online bootcamp Bloc (www .bloc.io). Post-graduation, most students pursue junior software developer jobs with high five- or low six-figure salaries, he says. Some make lateral transitions with their current company, but most land new jobs. Although a select few people can obtain job-ready coding skills on their own, Schmidt says, many students eventually encounter a "zeitgeist moment" when they realize "hacking alone with videos won't suffice." Thus, they seek guidance.

Jon Stowe, president of Dev Bootcamp, says Dev Bootcamp's short-term, immersive bootcamp model transforms students into job-ready, full-stack Web developers in 18 weeks. (A 19th week is devoted to career preparation.) The model is dubbed a "bootcamp" because it's rigorous, immersive learning that requires the

complete commitment of students, he says. Anna Lindow, general manager, campus education and operation, at General Assembly, describes the institution's full-time immersive programs as "intense, transformative, and effective experiences" focused on teaching applicable, relevant skills as informed by industry research. "Accelerated learning programs can kick-start your career in a way that's unlike anything else," she says.

Most bootcamps involve in-person, immersive learning that requires students to travel or relocate to the bootcamp's city where they partake in days often stretching 12 hours or more. App Academy (www .appacademy.io) is one such bootcamp with an intense culture. Daniel Filous, director of marketing, says App Academy packs about 1,000 hours of learning into 12 weeks, which equates to about two years of upper-division courses at a standard four-year university. Though intense, he says, the

environment "builds a personal connection between students that's difficult to replicate in any other environment." Thinkful (www .thinkful.com), meanwhile, is an online bootcamp in which students work with mentors at their own paces, something that benefits those who can't attend an in-person bootcamp. "90% of our students have full-time jobs while in our programs," says Darrell Silver, Thinkful co-founder, so Thinkful works with students to fit learning into their schedules.

Adam Enbar, president of Flatiron School (www.flatironschool.com), says while in-person courses can mean more personalized, immediate attention from instructors, Flatiron's remote-learning Learn-Verified platform uses the same curriculum as its in-person courses. "We've tried to eliminate the disadvantages online bootcamps typically have—namely a lack of individualized feedback and accountability," he says. Learn-Verified students can access faculty 18 hours a day and other students 24/7. They also work with the same job-placement team as in-person students.

Whether online or in-person, most bootcamps teach skills that go beyond strictly coding. Stowe says Dev

Course Report, which closely tracks the coding bootcamp market, has a wealth of articles, interviews, reviews, reports, surveys, and other information for those considering a bootcamp.

Bootcamp's approach emphasizes three components: "hard skills" required to obtain a development job, "soft skills" required to perform in modern work environments, and "metacognitive skills" needed to optimize learning so students "can stay ahead of the constant evolution of technology in this industry," Stowe says. Dev Bootcamp also emphasizes building student camaraderie to enable cooperation, communication, and leadership, all of which are likely to increase the odds of success, Stowe says. Further, students are exposed to emotional intelligence and awareness training, free counseling, paired-coding and cohort bonding, and student-originated activities and traditions.

Although some bootcamps have strict admissions processes, others will work with anyone interested in coding. Bloc, for example, believes anyone with a desire to learn and a willingness to commit the time and effort can learn to code, says Schmidt, who says the traditional classroom model some bootcamps use can do a disservice to those who learn faster or slower by "teaching to the middle." Using an apprenticeship model enables Bloc's mentors to work one-on-one with students and adapt as needed, he says.

Although most people attending Dev Bootcamp have previously tried free or online coding courses/resources and know they want to pursue coding as a career, Stowe says, they enroll in a bootcamp for the structure and community provided by an immersive model. "They really want to be among a cohort of like-minded learners and to learn from our experts, all of whom were developers first," he says. "It's like the difference between learning Spanish from an online course vs. actually going to Spain for 18 weeks." Live full-time instructors, a partner-pairing approach, and a collaborative supportive culture engage and motivate those who might find it difficult to self-motivate or overcome difficult challenges alone, he says.

The Camper's Life

It would seem logical that someone attending a coding bootcamp would have at least some coding experience, but not everyone does. Demographics data that Course Report gathered this year from 665 bootcamp graduates found only about 5% were employed full-time in software development before attending bootcamps. About 33% had no pre-bootcamp software developer work experience. Overall, Course Report found the typical bootcamp attendee is 31, has 7.6 years of work experience, and has at least a bachelor's degree but has never worked as a programmer.

Certain personality traits can help those lacking coding experience succeed in bootcamp settings. Lindow cites grit, an ability to overcome obstacles, and the ability to be a force of positivity as examples that can lead to success in accelerated learning settings. Similarly, Enbar says although Flatiron School

Key Facts

Course Report (www.coursereport.com), a coding bootcamp review site, has conducted numerous surveys and research in recent years concerning coding bootcamps and their graduates. The following are some of its findings:

- The U.S. coding bootcamp market is estimated to grow 2.4x between 2014 and 2015; graduates are projected to increase from 6,740 to 16,056.
- Average tuition for a full-time bootcamp is about $11,000.
- The average bootcamp lasts 10.8 weeks.
- The U.S. market will see $172 million in estimated tuition revenue this year, up from $52 million last year.
- The number of U.S. bootcamps offering full-time programming courses jumped from 43 in 2014 to 63 this year.
- Cities with the most bootcamps are San Francisco (12), New York (nine), Seattle (eight), Portland (six), and Chicago (six).

FULL-TIME EMPLOYMENT

66% of graduates surveyed report being employed in a full-time job requiring the skills learned at bootcamp, with an average salary increase of 38%.

66% % of grads employed as developers

38% Average salary increase

$18K Average Salary Lift
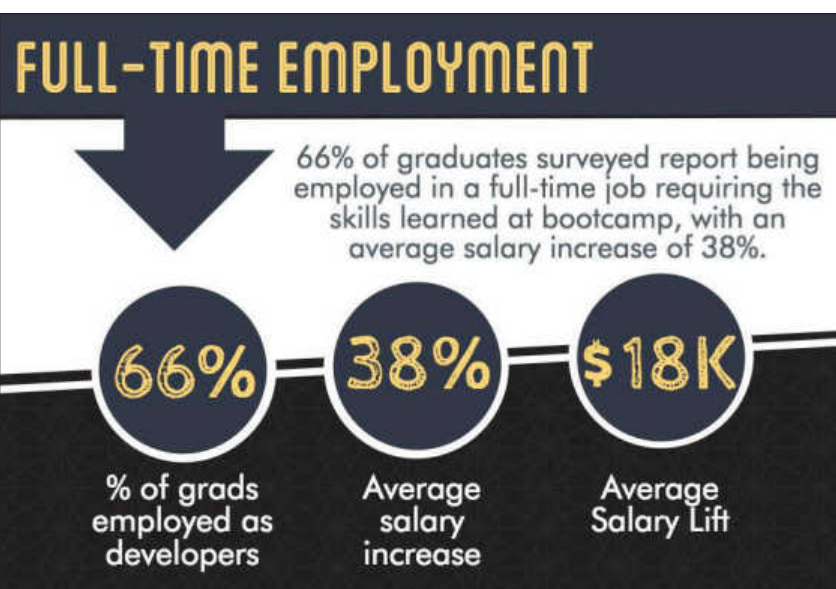
According to the Course Report's "Alumni Outcomes & Demographics Study," 66% of graduates indicate they are working in full-time job that requires skills they obtained at a bootcamp. On average, their salaries increased by 38%, or about $18,000.

students come from extremely diverse backgrounds, all share a desire to become great developers. "Our strongest applicants may not have any programming experience, but they have already demonstrated some initiative in learning how to code, whether that means taking free online courses, attending meetups, or reading books on it," he says.

App Academy notes successful students typically like learning on a deep level and are intrinsically motivated and interested in learning software development and computer science, Filous says. They're also comfortable asking numerous questions and are persistent in fully understanding answers before moving on. Anyone can theoretically learn to code, Schmidt says, but those with some transferable skills

have an advantage. For example, because computer programming at its core is about writing a new language and describing specifically what a computer should do, skills that translate well include speaking multiple languages, math, music notation, spreadsheets, technical writing, and finance.

Prior to enrollment, some bootcamps require students to complete pre-bootcamp work or training in order to gauge their interest and commitment for coding and to give them a foundation to work from. Dev Bootcamp uses a "Phase 0" nine-week online prep phase that enables campers to hit the ground running upon arrival, Stowe says. Dev Bootcamp applicants are assessed based on cultural, program, and technical aptitude fits. "Ultimately, we're looking to determine if prospective students

demonstrate both the real underlying desire to learn Web development (or if they're more interested in the salaries in the industry) and the intellectual rigor and persistence to learn effectively in our environment," he says.

The daily regimens at bootcamps vary, but Hack Reactor (www.hackreactor .com) provides a glimpse on its website of what to expect from an in-person bootcamp. After starting the day detailing what students will work on and need to do the work, Hack Reactor students might partake in hack/pair programming; exercise; learning high-level meta-engineering skills focused on project management, team communication, and code documentation; in-classroom dinners; and evening sessions involving guest

A Letter From Camp

For most of her career, Ginny Martin worked within tech companies in business strategy and operations capacities leading product development, sales, marketing, finance, and other efforts. Although Martin helped build and grow those companies, she acknowledges it was software developers who provided the fuel. Martin had a deep interest in knowing how they built that software. Ruling out a computer science degree, she ultimately choose a coding bootcamp to do so. "I happen to love difficult, high-growth, immersive experiences, and the words 'software development bootcamp' got me excited," she says. Ultimately, Martin attended Dev Bootcamp (www.devbootcamp.com) in San Francisco for 18-plus weeks, leaving behind a family in Lincoln, Nebraska.

Beyond coding, Dev Bootcamp's curriculum focuses on the development process, the development workflow, software developer collaboration skills, and developing better emotional intelligence. Via the teachings and a focus on the relational/behavioral aspect, Martin got practice working with others in new ways and getting feedback. "We were all working really hard together to learn all this and formed really close relationships," she says. "I found it really energizing to be around a group of people who were in such a growth mindset.

Prior to Dev Bootcamp, Martin had a strong working knowledge of basic office software packages as a user but wasn't necessarily very technical.

Ginny Martin says she tapped into all of her emotional strength while attending the Dev Bootcamp in San Francisco.

"So I had a lot to study to begin to understand Ruby, the language on which we were tested during the interview process," she says. Though she "bombed" her initial interview (which combined live coding and problem-solving), Dev Bootcamp granted her another interview, raising "the bar on the material I needed to learn," she says.

Martin says the volume and complexity of challenges thrown at students daily at camp made it difficult for anyone to complete the workload. "I believe this was by design and so the most talented software engineers could be pushed," she says. The approach meant Martin had to tap into all her emotional strength. "I was surprised at how much of a perfectionist I was, which did not serve me well, and once I increased my self-awareness around this perfectionism, I relaxed and performed at a higher level," she says.

Martin says while many obstacles to attending a bootcamp are real (lost income, cost, family, and relationships), "if it's something you really want to do, make a list of the obstacles and consider who can help you remove them. Then, ask for help." She also recommends removing all distractions for the duration of bootcamp, eating healthy, sleeping eight hours, and exercising—"all key performance enhancers for problem-solving and endurance."
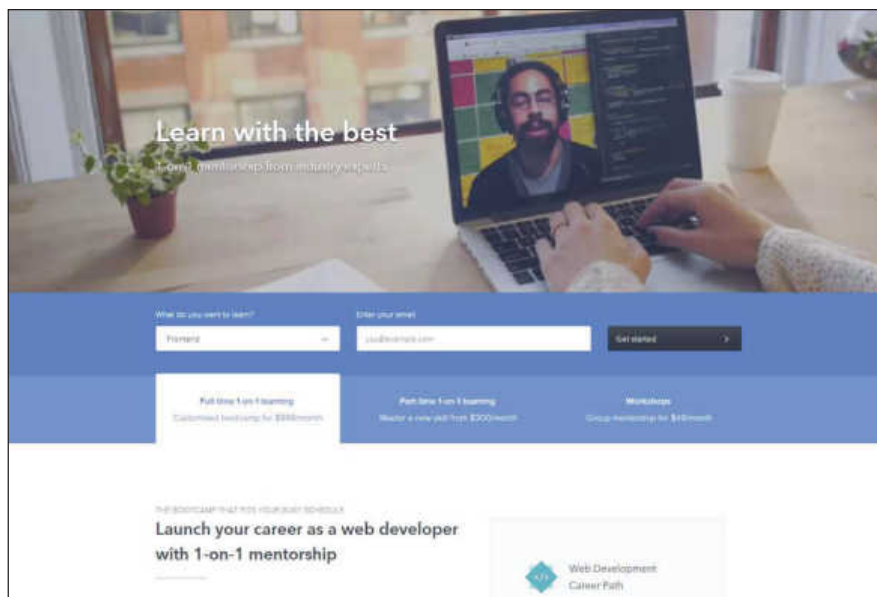
Thinkful is an online coding bootcamp that matches students with mentors who work one-on-one with students and adapt curriculum to the student's skill level and goals.

speakers and teachers, attending meetings, mock interviews, and more. Often, students work well into the night.

SwitchUp data indicates the average bootcamp class size is 27 students, similar to a community college class but smaller than university classes. On average, there are 3.5 instructors per coding bootcamp class and a 1:8 student-to-instructor ratio. In terms of actual learning, sources indicate Ruby on Rails and JavaScript currently are the most popular topics among students. A Course Report study found Ruby on Rails is used in 35% of bootcamp courses, and 9,748 graduates will emerge as Ruby developers this year. JavaScript is used for 21% of courses. According to data compiled by Quartz, the most valuable programming skills based on average salary are Ruby on Rails ($109,460), Objective C ($108,225), Python ($100,717), Java ($94,908), C++ ($93,502), and JavaScript ($91,461).

Lau says although many bootcamps teach Ruby on Rails because it's in demand, the market currently is slightly saturated with junior developers. Not as many bootcamps teach Python, he says, despite the job market being just as strong. "So students might want to consider a tech stack where they gain an advantage in a slightly less-competitive environment," he says. "JavaScript is another one. There's a huge demand for JavaScript developers, front end and back end, and there aren't as many bootcamps teaching it right now."

Overall, Web development, user interface design, and mobile app development are strong focus points. "Students are looking to learn the technologies and techniques employers need," Silver says. "That's why most bootcamps, including Thinkful, focus on Web development." Filous says App Academy emphasizes providing a framework that enables learning new concepts and languages quickly, thus someone who wants to learn Python after graduation has the framework and grounding to do so. Further, graduates working at any company running on any language can get up to speed faster than students from traditional computer-science programs, he says. Often, Stowe says, Dev Bootcamp students end up teaching themselves a new framework such as Node.js or Angular during the program's last phase and incorporating that into their final projects.

The Reaction

Something impossible to miss concerning coding bootcamps is the job placement rates many bootcamps advertise, including claims of 98% or

Chief Considerations For Camping

Would-be coding bootcampers need to carefully weigh various considerations before selecting a bootcamp, including cost, location, and quality of education provided. Helpful guidance and tools are plentiful online, including from the bootcamps and such bootcamp review sites as Course Report (www.coursereport.com), SwitchUp (www.switchup.org), and Bootcamps.in (www.bootcamps.in). SwitchUp provides career quiz and matching tools, for example, while Bloc (www.bloc.io) provides a True Cost Of Coding Bootcamps calculator. Course Report has information regarding student loans and scholarships, calculating ROI, and much more.

SwitchUp Founder and CEO Jonathan Lau says to ensure the bootcamp you're considering is located where you want to take a job and that the bootcamp has solid contacts there. Additionally, note the technology stack the bootcamp emphasizes, as certain stacks are in more demand than others. Also compare bootcamp reviews and ratings, determine who provides instruction, talk with alumni, and get a good sense of a bootcamp's community and staff "because that's what really makes or breaks your experience," he says.

Arguably, cost is the key consideration for students. If you're attending an in-person bootcamp, account for tuition but also living costs. Lau recommends budgeting $2,000 to $3,000 per month depending on the bootcamp's city. Also budget for post-graduation expenses if the job hunt stretches out. "If you don't have the financial cushion, you're going to be really stressed," Lau says.

Flatiron School guarantees those students who are admitted to its Learn-Verified program will find a job within six months or it will refund their entire tuition, which costs $1,000 a month.

99% of graduates receiving job offers upon graduation.

Course Report 2015 data found that 66% of graduates are employed full-time in a position that requires skills they acquired at a bootcamp, and 89% of graduates found full-time jobs within 120 days of graduating. Graduates are getting jobs in positions such as software engineer and as Web, software, front-end, junior, full-stack, and associate software developers. Graduates saw an average 38% bump in salary, or about $18,000, after graduation. Low-income students saw a $36,000 increase in salary. Undergraduate music majors interestingly saw the biggest increase, while foreign language majors were most likely to get hired as developers.

Ultimately, Lau says coding bootcamps are businesses that need to make money, which they do by getting students to attend. They do so by making "it sound like they'll get a job right away," he says. "It's not necessarily false advertising because they don't necessarily say things that aren't incorrect, but they do twist the truth a little bit and make it seem rosier." He advises students to factor in a couple months after graduation to land a job and

longer for weaker candidates lacking a technical degree background.

Flatiron School actually guarantees job placement for those qualifying for its Learn-Verified program, and App Academy doesn't require students to pay

tuition until finding a job as a developer. At Flatiron, a job-placement team works with companies dubbed "hiring partners," which include tech giants, startups, and media companies. Flatiron's Enbar says the team helps match new graduates with job openings based on their interests and strengths. App Academy's Filous, meanwhile, says removing money from the equation enables App Academy to select students from a group of applicants "an order of magnitude larger than other programs who have high, upfront, fixed costs of $12,000 to $20,000." This "allows us to run a truly meritocratic admissions process, where students are selected based on their potential to succeed and not on how much they can pay," he says. "Ultimately, we're making an investment in our students, and it's having skin in the game that really forces us to be extremely thoughtful at every aspect of the program."

Pinning down exact job-placement stats is difficult, but what's easy to decipher is that graduates and employers are expressing an extremely positive reaction to coding bootcamps. A 2015 survey of bootcamp alumni from Course

Online vs. In-Person Bootcamps

Online and in-person bootcamps have their own distinct pros and cons. In-person settings tend to build community, allow for real-time Q&A, and create "accountability partnership" or "assistance in achieving goals," says Anna Lindow, general manager, campus education and operations, at General Assembly (www.generalassemb.ly). "It can be easier to tune out or fall behind when you don't have to show up to a place and hand in assignments on deadlines," she says.

Because in-person bootcamps are full-time, students typically must quit their jobs and potentially move to a new city. Online programs, says Darrell Silver, co-founder of Thinkful (www.thinkful.com), aren't as disruptive. About 90% of Thinkful's students keep their jobs while enrolled, "which is far less risky and less expensive because they don't forego earnings for the months while they're enrolled," he says. Clint Schmidt, COO of online bootcamp Bloc, says online bootcamps also enable working one-on-one with mentors or developers vs. in a classroom. Schmidt acknowledges some students value the camaraderie and group-learning environment provided by in-person bootcamps. "There's plenty of room for both in our industry," he says.

"Ultimately, there are benefits to both," says Daniel Filous, director of marketing at App Academy (www.appacademy.io). Online courses enable people anywhere to learn in the comfort of their homes and often at a deeply reduced price, he says. "However, the amount of focus, practice, and learning required to truly grasp these concepts at times can be difficult in an online environment."

The Government Sees Potential

Soon, a pilot program called EQUIP (Educational Quality through Innovative Partnerships) could prove pivotal for coding bootcamp students. Essentially, the experimental program, launched by the U.S. Department of Education, will let nontraditional skills-teaching groups such as bootcamps offer federally subsidized loans to students, something some believe will particularly benefit low-income students. The experiment will involve traditional accredited universities partnering with short-term programs such as coding bootcamps, as well as a third-party organization that monitors the effectiveness of the program.

Flatiron School (www.flatironschool.com), which has already completed an independent audit report concerning its student outcomes, recently partnered with Southern New Hampshire University and is applying to EQUIP. Flatiron School President Adam Enbar says EQUIP could potentially provide students the best of both worlds: "the benefits of having a traditional higher education or liberal arts education combined with the extremely high outcomes-oriented education that coding bootcamps and other nontraditional providers can provide."

Most students attending traditional colleges/universities are as interested in their personal development as in getting a job, he says, "so the goals of those institutions can be intangible and difficult to measure." Coding bootcamps, however, "are focused on measurable outcomes like job placement and high starting salaries that can and should be measured," he says.

Bloc COO Clint Schmidt and Thinkful Co-founder Darrell Silver say EQUIP is a step in the right direction, though Schmidt says partnering with accredited schools to deliver tech skills for credit could be "a dangerous back door to access federal student loans." Traditionally, most new bootcamp students commit significant time and money "with the explicit goal of starting a new career as a programmer," he says. "Part of what has made us so effective is every day we must prove the return on that investment to our students." Introducing federal student loans lessens that burden and could open the door to "chase easy dollars to bump revenue per square foot without being directly accountable for student outcomes."

Silver says many students get no support from their colleges for coding education, while many bootcamps are providing excellent education that isn't recognized as an invaluable part of college degrees. "EQUIP is hopefully the first step in a process to bring the world of accredited colleges with bootcamps together," he says.

Report found graduates gave bootcamps an average satisfaction rating of 8.42 out of 10. Employers, meanwhile, commonly laud the time and money commitment, work ethic, problem-solving abilities, and commitment to technology that bootcamp graduates demonstrate. Employers also note bootcamp graduates have work-ready abilities that some traditional university graduates lack.

Filous says employer reception toward App Academy's graduates is "really resounding." App Academy has placed 98% of its graduates, he says, some at major companies. "Those graduates tend to make significant contributions early in their tenure, making the decision to hire more App Academy grads an easy one for hiring managers," he says. Reception to Thinkful's graduates has also been excellent. Silver says with programmers in short supply, there's an incredible demand for technology skills across all departments. "In fact, the fastest-growing part of Thinkful's business is corporate training, where employers have existing engineers come back to our program to speed their learning of specific technology topics," he says.

Dev Bootcamp has graduated 1,800-plus students since 2012, and employers have been overwhelmingly enthusiastic, Stowe says. Beyond being solid coders, employers note the ability of graduates to learn quickly, "even languages that they have no experience with," he says. Employers also recognize graduates "can more effectively communicate, cooperate, and lead their coworkers" when working in teams in numerous diverse environments, he adds.

Not every bootcamp turns out skilled graduates, however, says Bloc's Schmidt. As such, there's a burden on hiring managers to identify the best candidates. Thus, Bloc routinely works with employers to place graduates from its Full Stack Web Developer Track "who've done the required work and created a portfolio of projects to demonstrate their skills." Bloc also updates its curriculum weekly based on feedback regarding the skills students need to possess to succeed.

Some detractors make a broad argument that rather than acquiring skills that translate into a "career," bootcamp grads are only acquiring specific skills that translate to "job." Stowe, however,

says Dev Bootcamp's strategy for student success entails rigorous training in software development fundamentals; quality teachers with years of professional experience; practical, hands-on coursework that simulates real-world product development scenarios; and more. "Some of our earliest graduates are now senior engineers and team leads," he says. "Several are leading entire engineering groups. That is more than a job."

Long-term, some experts predict that as the bootcamp market grows and more graduates emerge, supply will draw even or surpass demand. Lau believes this will mean the stronger, more competitive candidates will secure the really good jobs. "Right now, demand is still higher than the supply, so everyone wins. In five to 10 years, when there are 600 bootcamps vs. 200 and 50,000 graduates a year vs. 10,000, those jobs are going to get filled much faster, and it's going to be harder to get your foot in the door," he says. "The industry will have to evolve and provide more training, better curriculum, and better intern experience. Only the best bootcamps will survive I think." ∎

CPU
Game Of The Month

Yeah, we know you have blogs to post, video to encode, reports to write, and code to compile. We do, too, but you have to take a break once in a while (and maybe blow some stuff up). That's why each month we give you the lowdown on what to expect from the latest interesting games.

In Fallout 4, The Cat's In The Cradle

BY ANDREW LEIBMAN

$59.99 (PC, XOne, PS4) • ESRB: (M)ature
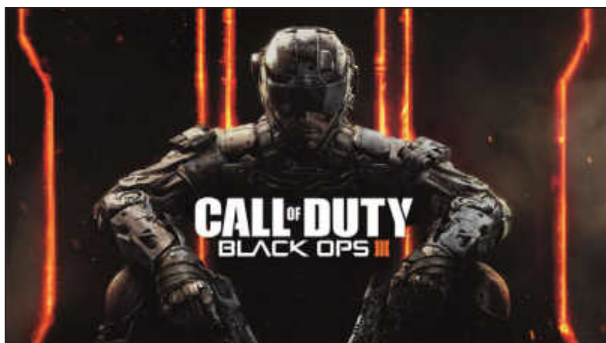Bethesda Game Studios • www.bethesda.net

Fallout 4 opens with the world as it was before the bombs fell. You're a happily married man or woman (your choice) exchanging witty banter with your spouse while your infant son coos from the nursery. The retro-futuristic suburban setting at the height of the atomic age is fun to see. There's your hovering robotic manservant named Codsworth, a sofa-sized console record player, a breakfast cereal unabashedly called Sugar Bombs, and a ceiling-mounted mixer, presumably for whipping up industrial-sized batches of Fancy Lads Snack Cakes. It's sunny, colorful, comfortable. And then all hell breaks loose.

210 years after the Great War, something went wrong in Vault 111. Your cryo-chamber malfunctioned and not even the conniving Vault-Tec planned what happens next. When you take your first hesitant steps into the wasteland wearing a blue jumpsuit and wielding a battered 10mm pistol, the only thing on your mind is reclaiming your son and exacting your revenge.

Although technically the seventh full game to bear the Fallout title, Fallout 4 is only the third developed by Bethesda Game Studios, which remolded the franchise into a first-person open-world RPG à la The Elder Scrolls with 2008's Fallout 3. For returning Fallout fans, it won't take long to acclimate to the new game; the controls, menus, time-freezing V.A.T.S. (Vault-Tec Assisted Targeting System) combat, and scads of seemingly useless detritus to plunder around every corner are all back and largely unchanged.

One of the things that has changed is that in Fallout 4, all that garbage can now be converted into raw materials you can use to craft your home base, and later, satellite settlements. Although they're nowhere near as deep as Minecraft,

Fallout 4's crafting and building mechanics give you plenty of freedom to go big. And players who tend to pick up every toaster, bowling ball, and plastic spoon will be rewarded with the ability to build more and bigger.

Gunplay is improved compared to previous Fallout games, though melee combat is still awkward and unwieldy. The character models, lighting, and environments look significantly better this time around, but the graphics can't compete with those of most modern FPSes. But that's not the real draw here. The improved voice acting, character animations, weapons, immortal traveling companions (Dogmeat FTW), and power armor modding are all great. The missions seem better designed and more imaginative, and many (though not all) characters are interesting and three-dimensional. Humor and tragedy are present in seemingly equal measures. The annoying—but not game-breaking—glitches are here as well, and for Bethesda, it's par for the course.

There's a lot of great stuff in Fallout 4. But the thing that keeps us coming back to post-apocalyptic Boston is the excitement of exploring every decrepit nook and cranny of this ruined world, to keep pushing to that mist-shrouded building on the horizon, to track down that errant distress signal, to see what lies at the bottom of a cleverly obscured cave, and to uncover the mystery behind a note that a skeleton was clutching.

We're going to apologize to the infant son that is Fallout 4's MacGuffin right now. We promise we'll find you, and when we do we'll unleash a special kind of hell on the jerks who took you. Eventually. Just not yet. ∎

A Target-Rich Environment

BY CHRIS TRUMBLE

$59.99 (PC, XOne, PS4) • ESRB: (M)ature
Activision • www.callofduty.com

Referring to Activision's latest blockbuster shooter as "a game" is a bit of a misnomer; in truth, it's more like a full suite of entertainment products, each of which is good enough to keep shooter fans coming back for more long after the novelty wears off.

Of course, the centerpiece is the Multiplayer component of Black Ops 3, which is a common thread among Call of Duty games, and the ever-popular Zombies co-op game is back and is also quite good. The biggest surprise this time around is the size and scope of the Campaign mode, which isn't just a loosely strung-together series of levels whose sole purpose is to train players for multiplayer, but instead is a sizeable game with a well-thought-out story and quality voice work by Christopher Meloni ("Law & Order"), Katee Sackhoff ("Battlestar Galactica"), and more.

We don't want to give too much away, but in Campaign your character starts out as a "normal" spec ops soldier on a mission to extract a VIP from an enemy base a few decades from now. The mission goes sideways, and you need major surgical augmentations as a result; the cybernetic tech that becomes part of you during this process informs a whole range of new game mechanics that you will learn to use over time, and that definitely spice up BO3's multiplayer as well. You'll learn to run faster, jump higher, run along walls, hack hostile drones and turrets, and extract information from computer systems and enemies with their own cybernetic implants.

Although fully robotic soldiers exist in the game's world, your new unit's CO (portrayed by Meloni, also cybernetically enhanced) believes that the human element will always be superior, and the story spends a considerable amount of time exploring the themes of what it really means to be human and of what makes you you.

BO3's Multiplayer is magnificent; it is fast and gorgeous and pits cybersoldier against cybersoldier in a wide range of game types. As in past CoD installments, there are a ton of weapons to master, and they level up as you use them. There are also a variety of character perks that give you enhanced abilities, make you harder to find, and so on, and they equip in slots on your loadout screen just like weapons. In BO3, however, standard shooter fare is augmented by players' abilities to run along walls, scale sheer vertical surfaces, boost jump, and so on, resulting in lots of cool new level design elements that savvy players will learn to use in changing the rules we've followed for years in traditional FPS games.

Zombies mode is tremendously deep for a mini-game, and it features its own compelling story ("Shadows of Evil"), as well as characters voiced by Jeff Goldblum, Ron Perlman, Neal McDonough, and Heather Graham. Action takes place in a fictional 1940s city and includes fortifications to bolster, new weapons to acquire, supernatural abilities to master, and a mysterious narrator that doles out information as players progress in the game. If you're a co-op fan, Zombies should be on your to-do list.

Finally, as if the Campaign, Multiplayer, and Zombies play modes aren't enough to keep you occupied, Treyarch throws in a meta-game called Dead Ops Arcade 2, the sequel to a top-down twin-stick shooter that was introduced in Black Ops 2. This is a game that your character can play once you complete the second mission and enter the team's safe house, and it's just one of a number of bonus activities and play modes bundled into BO3.

In short, there is an awful lot to see and do in Call of Duty: Black Ops 3, and it's all a great deal of fun. If you like the game as much as we do, you'll probably still be playing it when the next Call of Duty hits the streets. ■

By Jove! The Templars Have Another Doodad Of Eden!

BY ANDREW LEIBMAN

$59.99 (PC, XOne, PS4) • ESRB: (M)ature
Ubisoft • www.ubisoft.com

After eight previous main titles, it can be difficult to keep up with the millennia-spanning spat between the Assassins and Templars. Assassin's Creed Syndicate continues the story from the POV of "the Initiate" who stands in for the modern-day player character. But for the overwhelming majority of the game, you're jacking into the genetic memories of Jacob and Evie Frye, a pair of assassin twins. The former has more combat-focused skills and the latter is more stealth-focused.

The franchise has always excelled at creating living, breathing worlds that look and feel incredibly authentic. In Assassin's Creed Syndicate, this has never been more true. Victorian England at the end of the Industrial Revolution is a sight to behold: the wide-bricked thoroughfares are filled with horse-drawn carriages that splash through reflective puddles lined by numerous familiar landmarks, including the Tower of London, Buckingham Palace, Saint Paul's Cathedral, the Palace of Westminster, Trafalgar Square, and more. The muddy Thames is jammed with steam ships, barges, and rowboats you can use as moving platforms; a locomotive that serves as your base of operations chuffs through the city; and factories belch smoke into gorgeous skyboxes with dynamic weather and breathtaking sunsets.

As always, you'll rub elbows with the period's biggest names. A socially awkward Alexander Graham Bell supplies you with voltaic grenades and other gadgets. You enlist the help of Charles Darwin to root out a phrenology-obsessed Templar. Florence Nightingale offers her thanks for delivering life-saving medicine to treat sick children. Want to hunt down Jack The Ripper? That's in the DLC. There are microtransactions to shorten your path to better weapons and armor, but you can still grind for them the old-fashioned way.
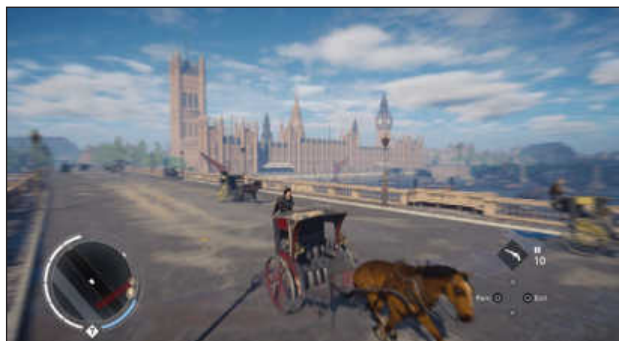
Regarding the setting and characters, Ubisoft Quebec took enough artistic license to make an auditorium full of history professors cringe, but hey, it's a videogame. As you play, however, you'll constantly be telling yourself this to excuse the frequent breaks in immersion. Drivable hansom cabs and growlers, which you can commandeer GTA-style, are fast but handle awfully. This leads to comically careening through street lamps and post boxes without slowing down and colliding with buildings and other carriages in ways that should leave your horses in a crumpled mass. The police are everywhere, and when on foot, they'll throw down if you so much as look at them, but they seemingly turn a blind eye to smearing crowds of street urchins on the way to your destination.

The new grappling hook/zip-line tool does take the tedium out of endless climbing, but sadly you can only latch onto certain ledges, from certain places. Failure is not as simple as being too far from a given ledge. As a result, we often found ourselves running around mashing the LB button in the hopes that we'd soar into the air and out of danger.

This game is a series of very long to-do lists. Some of our favorite activities included zipping between rooftops, unlocking the map to grow the ranks of Jacob's street gang, and hunting down collectibles. Syndicate's new Gang War missions let you take on large groups of enemies, but until you've maxed out your combat skills, these can test your patience.

If you enjoyed previous AC games, you'll dig this one. But if you're hoping this game rocks the boat with regard to the "Templars are bad, let's take away their magic toys" story beats, then you will be disappointed. Oh, and those looking for boats will be disappointed, too. ■

Blizzard's Space Opera Sings Its Grand Finale

BY VINCE COGLEY

$39.99 (PC) • ESRB: (T)een
Blizzard Entertainment • us.battle.net

The prospect of reviewing the final chapter of the StarCraft saga, which started way back in 1998, is a vexing one. For me, at that time an impressionable young teenager, StarCraft was a revelation—an RTS with a compelling story, a game that improved and expanded WarCraft's model in innumerable ways, and a damn fun game that was all but impossible to put down. And I'm not even including Brood War in the mix.

I don't know that I can be truly impartial about a series that has meant so much to me over the years, but I'll try.

Because SC1's story was the hook that drew me into the game, it's LotV's tale that I'll put under the microscope first. Without revealing specific details, the final struggle of Raynor, Kerrigan, Zeratul, and Artanis against Amon, the ancient Xel'naga who is basically evil incarnate, is at once everything that's good and bad about Blizzard's storytelling. Certainly, Blizzard knows how to create epic conflicts, but the problem with painting with such a wide brush is that you can struggle with the details. Some of the dialogue is psi-blade-on-a-chalkboard painful, and too frequently Blizzard relies on good old-fashioned tropes such as applied phlebotinum to carry the plot forward (seriously, if an ancient alien race had access to this many miracle artifacts and wonder crystals, how did it allow itself to be wiped out by space cockroaches?). These are things the entire genre struggles with at one time or another.

However, one idea that really requires LotV to fully crystallize is that the SC2 saga tends to focus on galaxy-sized existential threats and messianic prophesies at the expense of the personal relationships that made SC1 so memorable. Perhaps the first game, and even Wings of Liberty and Heart of the Swarm, created expectations too lofty for LotV to meet, a case where "not great" and "good" *should* be synonymous but aren't.

Mechanically, LotV's campaign doesn't change the formula much. There are a few cool missions, but most of the time your objective boils down to "build up your Protoss death ball and flatten the enemy." Campaign-exclusive units (Reavers! Dragoons! *Dark Archons!*) are back again, and so are the skill trees that let you power up your forces for the end-game missions. To LotV's credit, the campaign feels like the most difficult of the three. Players who take on the game's Brutal difficulty will get their money's worth.

For a game that has been polished to a mirror finish over the years, the best parts of this last installment are the new multiplayer modes. Archon Mode lets players take control of the same base and seems to be an excellent way for experienced vets to teach newbies a few tricks. Co-op missions let players team up to accomplish objective-based missions (protect this outpost, disrupt that enemy convoy); the twist is that players take on the role of a StarCraft VIP (Raynor, Artanis, etc.) and receive unique bonuses based on the commander they choose. This wouldn't be a Blizzard game without XP, of course, as playing lots of co-op missions gradually gives players access to more bonuses that let them take on more difficult missions. It's an excellent way to expose players to SC2's multiplayer game without throwing them into the fire of the game's demanding and cutthroat traditional PvP, and it also gives the game an element of replayability that previous installments have lacked.

Speaking of replayability, Blizzard has announced plans to expand StarCraft's universe with additional DLC mission packs. (The first will focus on Nova, the fan-favorite Terran Ghost.) So, the best part about LotV's ending is that it's not the end. ∎

For bonus content, check out this article online at www.computerpoweruser.com/19227.

Q&A With Philip Cotton

Teaching Children Well On 3D Printers

While touring the United States last summer, Jonathan Jaglom, CEO of 3D printer maker MakerBot, witnessed firsthand how U.S. schools are using 3D printers in classrooms to enhance STEM education. One experience was so positive, it blew Jaglom's mind "like it hasn't been in years." Incidents such as that show how the topic of consumer 3D printers in the classroom is making news and drawing increased attention. Globally, forward-thinking educators praise the ability of 3D printers to help prepare current students for tomorrow's engineering- and design-driven workplaces.

If anyone understands the educational value of 3D printers, it's Philip Cotton. Twice winner of the 3D PrintShow Educational Excellence Award, Cotton has taught 3D printing to students at Ladybridge High School in Manchester, England, for years. Cotton also consults for the BBC; leads 3D printing workshops; writes about 3D printing; and founded 3DFileMarket.com, an online community and marketplace for 3D print files. We spoke to Cotton about 3D printers in the classroom and why they're important.

Q: Is it true that when you started teaching 3D printing, you were learning the technology on the fly?

PC: Yeah, that's true. I've been teaching seven years now. My degree is in industrial design and technology. I got a bachelor's degree in that from a real good university in the UK called Loughborough, which is really high-end. That was the first time I really saw a 3D printer. It was 2002, and the university had a printer that wasn't mainstream. I was exposed to it, but I never really used it.

To cut a long story short, about five years ago, I was thinking about how I could advance technology for the students I teach design and technology to in the UK. There are subjects that are constantly emerging, but I think I was getting a bit bored in the classroom with the same technology. The most advanced piece of technology we had in the classroom was laser cutting and CNC milling. I thought, "What else is out there?" I did a Google search for a new emerging technology, and 3D printing came up. I looked into it and thought, "This looks amazing." I knew it was going to revolutionize society and education and manufacturing. I did my research and thought, "I want a 3D printer for the classroom. This is what I need to do." I put a bid in with the head teacher to buy a 3D printer. The teacher didn't know what it was, and I basically said, "You have to trust my instinct on this. It's going to be big." I was excited about the thought of a 3D printer in the classroom, so they bought me a 3D printer.

Literally, about four and a half years ago, no one in the UK was making any noise about 3D printing. I couldn't find any other teacher who was 3D printing in the classroom. I know I wasn't the only one who knew what 3D printing was, but no one else was broadcasting, collaborating, and showing the world what 3D printers could do in education, so I was sort of stuck on my own. I thought, "Well, what should I do?" I unboxed it and put it to the kids and explained to them what was going to happen. "We have a machine, and at the moment there's nothing, but we're going to print an object, just like a 'Star Trek' replicator.

The iPhone 4 or 4s was the most popular iPhone at the time, and a student said, "Print me an iPhone case." I was like, "OK, yeah." The kids couldn't believe I could print an iPhone case. So I said, "For the next lesson, I'll design an iPhone case." We use 3D CAD/CAM in school and teach that to the kids. I said, "We'll design an iPhone case. I'm going to print one off and start the lesson, and by the end of the lesson there will be an iPhone case, and the lesson after we'll all model an iPhone case." And we did it. It was amazing. It was absolutely amazing to see these 14-year-old kids go home from school to their parents with iPhone cases they'd made in school by this crazy process called 3D printing that no one had heard of.

Q: How often do you have the chance to just explore in the classroom?

PC: In the UK, there's a sort of government curriculum that's

released and reviewed every few years. Literally, in this area there are just bullet points, and the teacher interprets those bullet points how he sees fit. However, it has to be in a way that educates the kids so they can pass their exams, but it really is open to the teacher's interpretation how he teaches. There's no rule saying if you teach new and emerging technology it has to be 3D printing. It could be anything—it could be Raspberry Pi—and I saw that 3D printing would fit into that part of the curriculum. Also, in my school, I'm the only technology teacher, and that's quite a good position to be in because no one can dispute what you're doing. If you're in a school with five or six technology teachers, you can get personalities dominating, so people are chiming in, "Don't do that, it's too risky" or "No, that's not going to work" or "What are you basing this evidence on that 3D printing is going to be massive?" In my school I have the freedom to explore, which is great.

Q: How would you characterize the 3D printing community today vs. the one that existed when you got involved?

PC: Well, the community has emerged a lot. When I first got involved, it was all sort of based around a replicate community and replicating, rapid prototyping. It was an interesting sort of community because it was very small and there were a few people who had really been heavily into it, and there weren't that many big companies that were market leaders. The Replicator 2 hadn't even been released when I was looking at 3D printing. There was the Thing-O-Matic, just the first-generation MakerBot. It was very much a hardcore techie community. It has emerged to where you have mainstream companies pushing 3D printing, and it's a lot more open to a lot more people, to the point where I have kids at school who've gone home and asked for a 3D printer for Christmas. And because they've learned it in school, their parents bought them 3D printers when they wouldn't have done

that without help through education. Big companies are also really getting into the brand and promotion and the education of people in 3D printing.

I do think the 3D printing community has a long way to go. It still needs to open up a bit more, but it's going that way. From where we are now with 3D printing, I liken it to when Apple started. Apple's computer was designed by Steve Jobs and Steve Wozniak in a garage in California. Now it's a world-leading company. 3D printers have sort of been made and developed in people's mockups and people's garages, and then they're expanding them and selling them and building them into reputable companies. So we're kind of in that emerging moment when it's raw, it's very fluid, it's exciting, but it's not fully commercialized yet. We still have a long way to go. And I actually think the sort of 3D technology we have now, FDM, the fused deposition modeling concept, will not be the end result. There needs to be further developments in the technology before it can really hit the mainstream because this idea of threading filament into an extruder and it extrudes out layer by layer, there are some issues with it that need to be ironed out.

Q: Some recent research suggests that classrooms will actually drive growth and sales of consumer 3D printers in coming years. Do you agree?

PC: It will. The classroom is vital, and 3D printing companies are desperate and fighting like cats and dogs to get their 3D printers into the classroom. I know that because I've been hounded by 3D printing companies. We actually have a school policy now that if anyone rings the school asking for me, the caller has to give details. The receptionist takes the name, the company, and where they're from. I get forwarded that, and if I want to ring them back I will. And that happens all the time. If I go to a 3D print show or any trade show and I have a teacher badge around my neck, I just get hounded because 3D printing companies know education is the key. Because if we

don't educate children on 3D printing, they're not going to follow through, and if you think of these big printer brands, any of them, if they get their printers into the classrooms, the kids are going to look at that brand, they're going to be familiar with it, and they're going to see what it does, and when they leave they'll probably be loyal to that brand because they've been educated on it. So these printer companies will do anything to get into the classrooms.

Q: Beyond the STEM-related benefits of 3D printing, in what other ways can teaching 3D printing potentially benefit students?

PC: We have to get a bit deep now. Why do kids go to school? They go to school so they can be educated, so that when they leave school they can go to a good job and contribute to society and better themselves and have a nice career. That's what we're trying to do. And if we don't educate kids in 3D printing, when they leave school they aren't going to be competitive in a global economy.

We have a situation where China is putting a 3D printer into every classroom. China is investing in design and technology so huge in its secondary schools that within a decade, China will be designing and manufacturing. Now the situation we have with China and a lot of Far East countries is they can manufacture but they can't design because they don't have the creativity skills. Now they're putting that in place, and 3D printing is a core feature of their curriculum. So if we didn't do that for kids here, if we didn't make 3D printing important . . . . It's so vital it's the equivalent of telling kids that they're going to school but they're never going to have a computer class. When they leave school, they will struggle without knowing how to use computers.

There's a bit of research that says right now in the UK, 60% of manufacturers are looking at integrating 3D printers into their companies. And that's now. If you imagine within a decade, pretty

much every manufacturer that prototypes a product is going to use 3D printing in some capacity. Well if we're not plowing out students who are literate in 3D printing, then what's going to happen? We're going to have to recruit from abroad. We already have a shortage of engineers in the UK and something crazy like by 2020, we'll need an extra million engineers. Where are they going to come from? It is a big deal to teach it. Something like 50% of kids when they're older will get a job in manufacturing in some capacity, so we're going to be exposed to it.

Q: You've written about the potential 3D printing offers for bringing certain topics to life. Can you explain?

PC: In my classroom, we encourage creativity. Kids have ideas they want to make. A lot of the time, the technology restricts them, and they can become disengaged because they can't actually do what they want. I've seen 3D printing solve so many problems where maybe a project would have to change or I would have to say, "No, we just don't have the ability to manufacture that." Well now we do. Even if it doesn't work, we'll do it again and give it a good go to 3D print it. It's that ability to sort of put the kids into the unknown where they're going to go and maybe redesign their model three or four times before they get a prototype that works—that excites kids. That project that may have been a bit mundane to some students now comes alive when you throw in 3D printing.

We're dealing with a generation of kids who are more technically literate than their parents. They are unbelievable on technology. We have to make sure in the classroom that we're pushing that ever further. If you're a technology teacher and you're still banding wood bricks together and making coffee tables or a chest of drawers, you really have to question what you're doing because in 10 years, when these kids leave school, if they want a chest of drawers, they're going to go to Ikea. They're not going to make

it themselves. It's getting them current on the technology that excites them. I've seen in my school in the past five years and through integrating 3D printing, the popularity of my subject has shot through the roof, and also the academic results of students has nearly tripled, which is great. It's not been easy.

Q: What are some of the more interesting ethical questions concerning 3D printing that are good discussion points for students?

PC: It's a great thing to discuss with the kids the ethical and social side of 3D printing. Obviously, we know 3D printing is exciting. It's going to revolutionize manufacturing. A lot of people in America and Europe think it's great because it will bring manufacturing of products back home from the Far East, and we'll be back in the good ol' days. But what about the fact that when we have these industrial revolutions (and China has just had one), when we bring manufacturing home, then these countries' economies are going to be destroyed, and if we don't outsource our manufacturing, then these countries, these economies, these jobs that rely on us, where will we be?

Then you also have the fact that PLA (polylactic acid) is one of the most popular plastics to print with. And

people are saying, "Yeah, it's great. It's environmentally friendly because they substituted the oil for corn." Scientists discovered that if you extract the starch from the corn and you can refine it, it has a very similar molecular structure to oil. So let's take oil out of plastic and put corn starch in, which seems great because

> We're dealing with a generation of kids who are more technically literate than their parents . . . . We have to make sure in the classroom that we're pushing that ever further.

that can biodegrade, so you can put your products in, and after they biodegrade after a year they'll be gone. Plastic? Hundreds of years to biodegrade, if not thousands.

That seems good, but what about the fact that we don't have enough land on this planet to harvest all the corn to meet our demand for plastic? What about the fact that corn would suddenly become a commodity and be traded over the stock market like oil and coffee, and that people's lives, very poor people who depend on corn as a food source, would suddenly have an important part of their diet taken away from them? What would happen if corn suddenly became the type of commodity that oil is? Would people be robbing the cornfields in the middle of the night? It's an extreme situation, but it's a good way to get the kids thinking about the ethical side of things that's not really discussed in 3D printing. It's those kinds of conversations—they're great for a classroom. ∎

For our full interview, go to

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lanfest.intel.com

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FADECON
Garland, TX
www.fadecon.org

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01.29-31.16
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Forever-A-LAN
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pong.uwstout.edu

02.18-21.16
PDXLAN 27*
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04.09-10.16
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LAN Gamers
Greenbelt, MD
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Q&A With Jack Sung

# ENERMAX's North American Marketing Manager On 25 Years Of Quality PC Products

Q: Earlier this year, ENERMAX celebrated its 25th anniversary. Can you talk a little bit about how the company got started? What was ENERMAX's first product?

JS: Yes, we have been around quite a while. We started as a power supply manufacturer. Twenty-five years ago, a computer power supply was one of the least important components in a PC build, but our founder Steven Su and his business partners realized that if the IT industry kept developing, there would be a need for PC power supplies. The quality and the specs of the PSU would also become a priority in the future. This realization is how ENERMAX was founded, specifically for PSUs.

The company's first products were AT/open-frame power supplies. They were putting out between 50 and 200 watts at that time.

Q: Looking at ENERMAX's milestone list, there are lots of firsts. In 2000, for instance, ENERMAX launched the first PSU with "vehicle-class coating" on its housing. Now, of course, all power supplies for enthusiast builds tend to have fancy finishes, right?

JS: I think the finishes give power supplies a really nice look instead of that bare metal industrial look. This idea was actually born circa 1997 when we made the first PSU with dual fans.
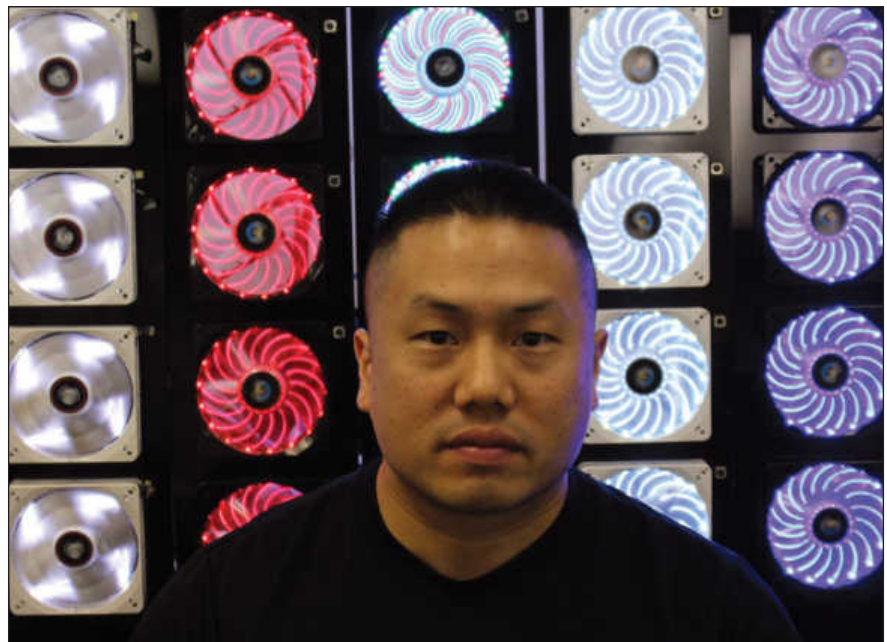
Since the dual-fan power supply was such a huge success, we wanted to innovate even further. The first question that came to us was, "How do we make a grey-looking box more appealing?" (PSUs were bare metal and quite ugly back then.) The idea of a coating came to us and we began thinking about the PSU not just as a component, but also as a visually appealing product. Those two innovations brought along a lot of other innovations like color retail boxes for power supplies, a comprehensive user's manual that came with each product, and the first full line of PSUs with modular cables. This lead to one of my favorite power supplies from ENERMAX that we released this year, the DIGIFANLESS. This was an industry first as it was both digital and fanless. My favorite feature is that it comes with an interface that will let you switch between single-rail and multi-rail functionality.

Q: OK, so you mentioned ENERMAX's first power supply with modular cables. How big was this for the company?

JS: This was huge for the company. The Liberty had three models: 400W, 500W, and 620W. From 2005 to 2008, we actually produced a whopping 400,000 units for this model line. A lot of awards were won with this power supply along with the hearts of reviewers and users alike.

During this time, users felt modular cables caused unstable voltage and had quality issues. We understood their concerns and worked hard to eliminate any negative conceptions of modular cables with the Liberty series. We tightened the tolerances for the connectors, and we also designed a special layout to strengthen voltage regulation. By doing so, we achieved a PSU with modular cables that didn't have any issues. Almost every PSU manufacturer followed in our footsteps. If you ever see a Liberty PSU, you can thank it for paving the way for all the modular PSUs today.

Q: Was ENERMAX's Galaxy also the first 1,000-watt power supply?

JS: To be fair, a competitor actually launched a 1,000-watt PSU in early 2006, and we did not launch the Galaxy until the middle of 2006. The very first 1,000W power supply that was released had native cabling and a lot of failures. We wanted to make sure that when we released ours to the market, it was the best—that was more important than being the first to launch. That Galaxy PSU had two fans (8cm and 13.5cm) and modular cables, and it was favored by overclockers everywhere. It also had high temperature resistance and was among one of the quietest PSUs on the market. It was simply the best EPS12V v2.92 PSU available at that time.

Q: What would you say is the most innovative product ENERMAX has launched in the past couple years, and why?

JS: I feel like I have been talking about power supplies a lot and there really is a lot of innovation from

ENERMAX's first modular PSU, the Liberty.

ENERMAX's LIQMAX II 240.

ENERMAX's DIGIFANLESS 550W PSU.

us on power supplies, but my personal favorite innovation has been in the cooling category. Our liquid CPU coolers come with quite a bit of innovation. The copper cold plate on the liquid CPU coolers have Shunt Channel technology that diverts the coolant to different channels in the micro fins, and that makes it dissipate heat better than a traditional copper cold plate. Another innovation that I really like in our liquid coolers is in the fans. Our fans have patented Twister Bearing technology. This technology is frictionless, and that gives the fans a long and quiet working life.

Q: The timeline cites the company's Aurora keyboard receiving a Red Dot design award as a milestone, and it's the first one that's not a power supply. When did ENERMAX first start branching out and making other types of products?

JS: Aside from power supplies, we continuously try to expand our product line. As a manufacturer, we try to ODM (original design manufacturer) different types of products according to customer's requests. Since 1991, we have developed keyboards and cases to manufacture.

Q: Today, of course, ENERMAX offers cases, fans, CPU coolers, and more. But is it safe to say that power supplies are still the foundation of the company's product lines?

JS: Power supplies are still our core business. They still generate more than 60% of the revenue for our company, so they are our bread and butter, but we have made a lot of strides in cooling technology, too. Apart from PC products, we will develop other products with the same enthusiasm and drive for innovation. I can't disclose what it is at this time, but I promise that I will in due time. ∎